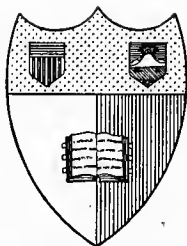


FLAX CULTURE & PREPARATION



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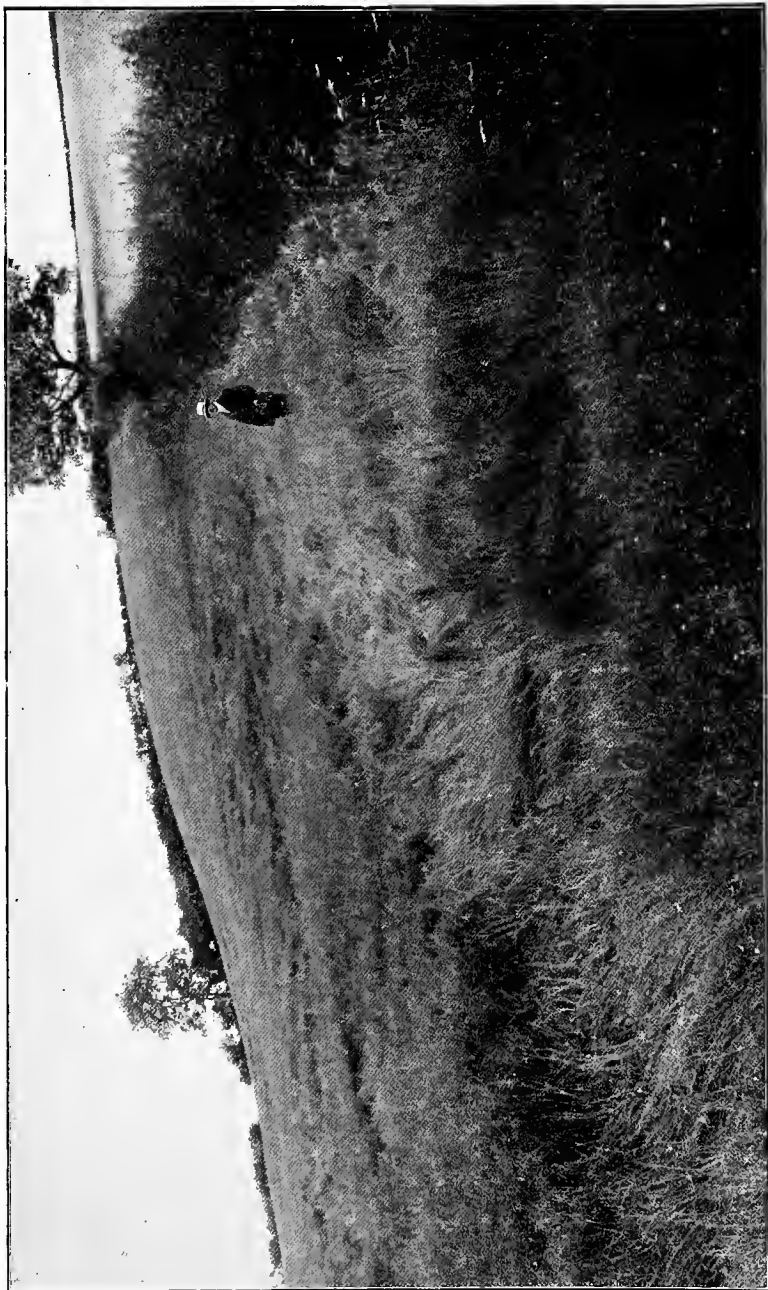
By ROBERTS BEAUMONT,
M.Sc., M.I.MECH.E.,

*Professor of Textile Industries, University of
Leeds.*

A Treatise on the Science and Technology of
Textile Colouring in Woollen, Worsted,
Cotton, and Silk Materials.

CONTENTS : Theories of Colouring— Attributes of Colours—Contrast and Harmony— Colour Standardization — Mixtures — Elements of Textile Colouring—Stripes—Check Patterns — Simple Colourings — Compound Colourings—Fancy Shades applied to Special Designs—Colouring of Combination Designs— Spotted Effects—Colouring of Double Weaves and Reversibles—Figured Textiles Coloured in the Warp—Weft-Coloured Figured Fabrics —Curl Textures—Index.

A FIELD OF GROWING FLAX



FLAX CULTURE AND PREPARATION

BY

FRED BRADBURY

*Professor Textile Industries, Municipal Technical Institute, Belfast; Author
of "Carpet Manufacture," "Jacquard Mechanism and Harness
Mounting," "Calculations in Yarns and Fabrics,"
"Worsted Preparing and Spinning," etc.*

WITH 91 ILLUSTRATIONS

LONDON

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PREFACE

FLAX, its cultivation and preparation, though ranking amongst the oldest of the World's industries, is nevertheless very imperfectly supplied with any publications which present in *seriatim* a complete description of the essential and possible methods connected with the selection of seed, suitability of land and its preparation, harvesting and handling of flax crops, including retting, scutching, preparing the flax for the market and the saving of seed for subsequent sowings or feeding purposes.

It was with a view of neutralizing to some extent this deficiency, that I consented to prepare for publication in book form the results of a long and enthusiastic study of the problems associated with the cultivation and preparation of this national, essential and commercial commodity.

Speaking generally, I have long been ardently interested, theoretically and practically, in flax cultivation and preparation. As a result of much study, numerous discussions with producers and experimenters, observations and tabulated experiences, I have naturally formed some definite conclusions, even on such a subject as Flax, in any branch of which, every experimenter and observer has a different opinion to offer. The substance of these experiences I have embodied in my lectures to the students at the Municipal Technical Institute, Belfast. These classes have recently been particularly well attended by successive groups of demobilized officers and men and farmers' sons who have gone, or are going out to British East Africa to grow flax, among other crops, for the mother country.

This volume embodies not only the above-mentioned lectures, but also includes an exhaustive description of the usual methods practised and the recent developments and modern methods of handling flax and the possibilities connected with flax cultivation from seed, to seed and fibre.

Incidentally, the future of the Linen Industry depends primarily for its continued success and increase upon the supply of its raw material—flax, and it is hoped that this treatise will contribute to encourage many to grow flax who hitherto never attempted to do so, perhaps, from a lack of knowledge of the subject, its natural importance and its remunerative possibilities. At the same time the work should be helpful in its suggestions to all others interested in the growth, preparation, spinning, weaving and distribution of linen materials.

My thanks are due to Mr. A. R. Hogg for permission to use many of his excellent photographs, most of which were prepared in collaboration with the author ; also to Mr. W. A. Green, photographer, Belfast, for a like privilege.

I am also indebted to Mr. G. Holt for his assistance, freely given, when dealing with soils and manures, and to Mr. F. M. Walker for many valuable suggestions in respect to flax seed and methods of harvesting same.

F. BRADBURY.

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FLAX CULTURE AND PREPARATION

CHAPTER I

THE FLAX PLANT AND FIBRE

1.—Flax Plant. 2.—Antiquity of Flax Cultivation. 3.—Modern Flax-producing Countries. 4.—The Uses of Flax and Seed. 5.—The Flax Fibre. 6.—Flax Fibre Characteristics. 7.—Ultimate Fibre. 8.—Chemical Composition of Flax Fibres.

1. **The Flax Plant.**—The genus or family of the flax plant is *Linum*. There is but one species known and cultivated of this genus—*Linum usitatissimum*, which yields a fibre characteristically suitable for textile purposes. There are two chief varieties of this species of flax plant grown for fibre purposes, viz.: I. *Linum usitatissimum, vulgare*—blue flower. II. *Linum usitatissimum, album*—white flower. The former variety or blue flower flax produces a fibre fine and good in quality, the latter produces a fibre stronger but coarser and of poorer quality than the former variety.

The flax plant is a cultivated annual ; the stem is commonly solitary, erect, elegant, and exquisite in appearance ; the leaves are alternate, lanceolate, and serrated. The *fibre* plant only branches out near the top and each piece terminates in a beautiful white or blue flower. As the flowers fade the round seed bolls or fruit capsules gradually develop. Each matured capsule contains ten seeds. Fig. 1 is a sketch of the flax plant in flower—drawn to $\frac{1}{8}$ scale.

The flower and seed bolls are shown full size at A and B.

2. *Antiquity of Flax Cultivation.*—From remote antiquity. Flax has been cultivated, prepared, spun into yarn and woven into textile fabrics. Many scriptural records give evidence of this fact. “Pharaoh arrayed Joseph in vestures of fine

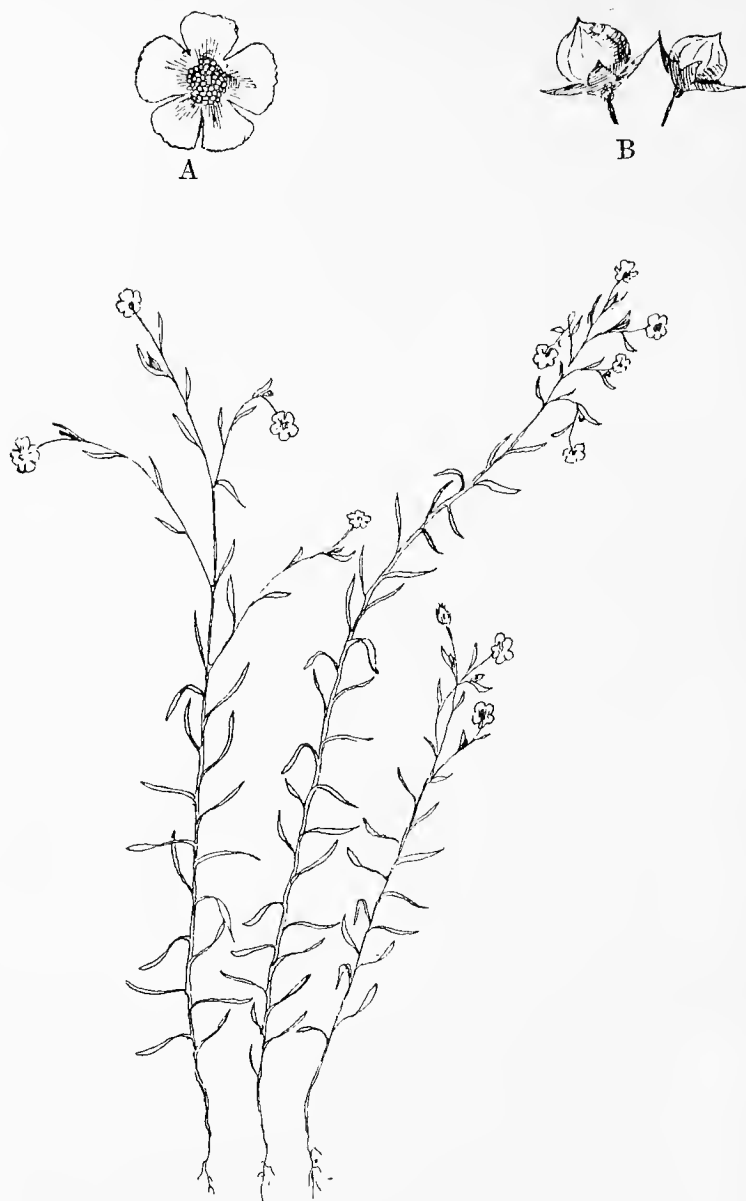


FIG. 1

FLAX IN BLOOM
One-eighth natural size.

linen." Linen was the material of which the priests' robes were made. The ten curtains of the tabernacle, the veil and the hangings for the door of the tent were to be of fine twined linen. (Ex. xxvi.)

"The flax and barley were smitten; for the barley was in the ear and the flax was balled; but the wheat and the rye were not smitten for they were not grown up." (Ex. ix. 31.)

Rahab hid the spies "with the stalks of flax that were laid in order on the roof." (Josh. ii. 6.) This suggests that Rahab used the roof for drying the flax.

Egyptian mummies, embalmed 1200 B.C., have been found wrapped in swathing cloths of fine linen.

The flax plant is supposed to have first been produced in the alluvial soils of the East, including that on the banks of the Nile. But the Egyptians not being a maritime people, it was left to traders to distribute their flax productions to all parts of the ancient world. The knowledge of the art of flax culture and manufacture gradually travelled to Greece, Italy, France, Flanders, Germany, and England. Flax growing was introduced into Britain by the Romans.

In 1175 it was classed among the tithable productions. In 1531 a statute was enacted requiring, under certain penalties, that for every sixty acres of land fit for cultivation, one rood must be sown with flax or hemp. In the register of St. Mary's Pulham, fines are recorded for the non-fulfilment of this law. From the reigns of Henry VIII and Elizabeth to the middle of the reign of George III flax-growing was established and protected by statute and assisted by legislation. Many were the attempts made during all these years to extend and improve the cultivation of flax.

Flax has always been, but never more so than now, an article essentially necessary to the British kingdom.

To trace the antiquity of flax culture and tabulate its developments and retardations through the succeeding ages, however interesting, welcome and inspiring is not the object of this treatise.

It is rather intended in this work to give first a general sketch of the present mode of cultivation, preparation, and management of flax and subsequently to describe fully the details of each operation. A regular system should be followed by those who cultivate flax ; attention must be paid to the nature of the soil, the necessity or otherwise of manure ; the kind and quality of seed, and the preparation of the land and harvesting of the crop. Every process connected with the cultivation, growth and preparation of flax is comparatively simple, requiring the activities of a practical hand, rather than an ingenious head.

3. *Modern Flax-producing Countries.*—The flax plant is indigenous to several countries. The suitability and climate of Ireland for flax cultivation is proverbial. The flax plant flourishes in cold as well as in temperate climates. The best flax-producing districts lie between parallels 48° to 55° N.

Flax grown for fibre purposes in warm climates, though it flourishes and produces seed of superior quality, is considerably improved in fineness and quality of fibre when removed to more temperate and cooler climates.

The chief flax fibre-producing countries in the world are : Russia, Holland, Belgium, Ireland, France, Italy, Germany, Austria, Canada, America and Japan.

4. *The Uses of Flax and Seed.*—The sheaves of flax do not differ much in appearance from the sheaves of wheat, oats, barley, etc., but the possibilities associated with flax cultivation, harvesting, preparation of fibre and seed, and their uses are very numerous. Flax is not only a remunerative crop, but it can also be made to provide a greater variety of vocations than any other farm crop. The great variety of yarns, threads, and textile fabrics manufactured from the flax fibres have ever been favourites and will undoubtedly continue to be so. The following are a few of the chief products from the fibres of the flax plant : Linen thread for tailors' and shoemakers' use ; thread for embroidery ; twine for jacquard harness mounting ; lines and nets for fishermen and all kinds of cords

and ropes. In the manufacture of woven fabrics, flax, when prepared and spun into yarns, enters into the composition of lawns, cambrics, handkerchiefs, canvases, pillow cases, sheets, blouses, dress linens, aprons, shirtings, collars, cuffs, surgical bandages, hollands, crashes, interlinings, balloon and aeroplane fabrics, and plain brown linens in all varieties of weight and fineness. Large quantities of material are required for the trades engaged in hemstitching, embroidery, and drawn thread work, including tray and sideboard cloths.

Towels—hand and roller, include the well-known huckaback and honeycomb structural standards. Bath and other towels of the “Terry” or loop class, when woven with linen yarns, have no compeer for drying purposes.

Toilet cloths of superior fineness and quality of material are produced in diaper and huckaback patterns.

Decorative or woven figured fabrics include damask table covers, “table tops,” carving cloths, serviettes and d’oyleys of the white series, but many serviceable and beautiful tapestry, upholstery and fancy vestings can be and are made wholly of linen or in combination with silk, wool, or cotton in two or more combinations of colour.

The miscellaneous varieties include *drills* for riding breeches, etc., *ducks* for tents and sail-cloths, also buckram, scrim, and lingerie textures. Lace textures composed of linen thread are produced in unending varieties.

The fruit or seed of the plant may be saved for subsequent sowings and propagation of its variety and species. The linseed, as it is commonly denominated, may be used as a fattening product for cattle when properly prepared and judiciously given. The linseed oil is extensively used in the mixing of paints and varnishes because it possesses considerable natural drying properties. It is this oil that gives the characteristic beauty to linoleum. When mixed with white lead, linseed oil excels every other substance in preserving wood. The oil-cake made from the refuse after the extraction of the linseed oil, possesses considerable feeding

properties and is consequently supplied to cattle for this purpose. The residue and chaff from the de-seeded bolls may be, and frequently are, crushed to a fine powder and mixed with other feeding stuffs for cattle and horses. Flax seed and chaff are excellent foods for increasing the supply of milk. The dust, leaves and waste combine to produce an excellent manure, and even the water from the flax pond may advantageously be run on to the land instead of into the nearest stream.

5. **The Flax Fibre.**—The flax fibres are obtained from the stem of the flax plant which is composed of three different substances—wood, fibre, and bark or skin.

Fig. 2 is a photographic reproduction of a piece of the flax stem, prepared to fully illustrate the location of the fibres in the flax plant. A is the root end of the plant stem. At B a portion of the internal wood has been removed. At C the flax fibres have been pulled from the internal wood and left attached in suspension from the stem.

Fig. 3 is a diagram of a transverse section of the flax straw as seen under the microscope. D shows the pith or wood centre, E the flax fibres and F the skin, epidermis, cortex, or bark of the plant.

The flax fibre is one of the bast tissues of the dicotyledonous annuals ; as shown in the diagram, it occurs in the concentric zone external to the pith D and inclosed beneath the cortex or skin F.

Flax, in its commercial form, is denominated *scutched* flax ; it is made up into separate handfuls of about 1 lb. each in weight. Fig. 4 is a photograph of typical scutched Irish flax. These handfuls are subsequently made up into bundles or bunches of about 2 stones in weight. To the casual observer the flax in its commercial form suggests that its fibre is of considerable length, but this visible length is artificial—it is simply a composition of aggregate bundles of ultimate fibres, longitudinally overlapping and held together by a gummy substance chemically denoted *pectose* (see Fig. 5).

Kolb defines *green flax* as containing a substance of a gummy nature to which the name *pectose* has been given. During the retting process this substance splits up into two definite compounds to which the names pectine and pectic acid have been given. The pectic acid is insoluble in water and remains attached to the plant until modified or removed

by the bleaching operation. Pectine is soluble in water and is washed from the flax during retting.

Fig. 5 illustrates in diagrammatic form the continuous bundles of overlapping fibres as they lie adhesively contiguous in their natural and commercial form.

Fig. 6 is a sketch of the actual fibre as seen under the microscope.

The length of the ultimate fibre varies from $1\frac{1}{4}$ to $1\frac{3}{4}$ in. or

30 to 45 mm. The diameter of the same averages $\frac{1}{800}$ to $\frac{1}{1000}$ in. The fibre from the finest sorts of specially selected crops exceeds this fineness and averages about $\frac{1}{1200}$ in.

The physical or mechanical structure of the flax fibre is multicellular as compared with the cotton fibre which is unicellular. In the series of operations subsequently described which prepare the flax for the market, the pith is rolled, dried, and broken into small particles of dust, leaving behind the long fibrous tissues of scutched flax in the hands of the scutcher. All the subsequent operations of roughing, hackling,



FIG. 4
SCUTCHED FLAX

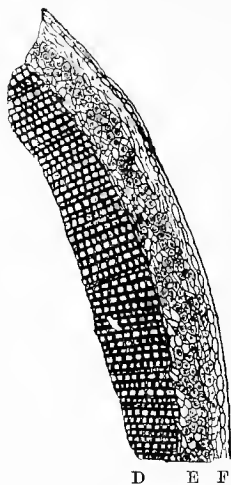


FIG. 3



FIG. 5

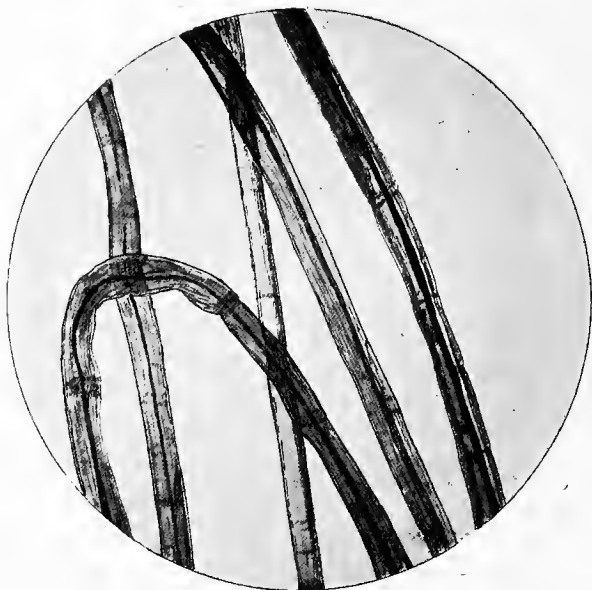


FIG. 6

PHOTOMICROGRAPH OF FLAX FIBRES

A

B

C

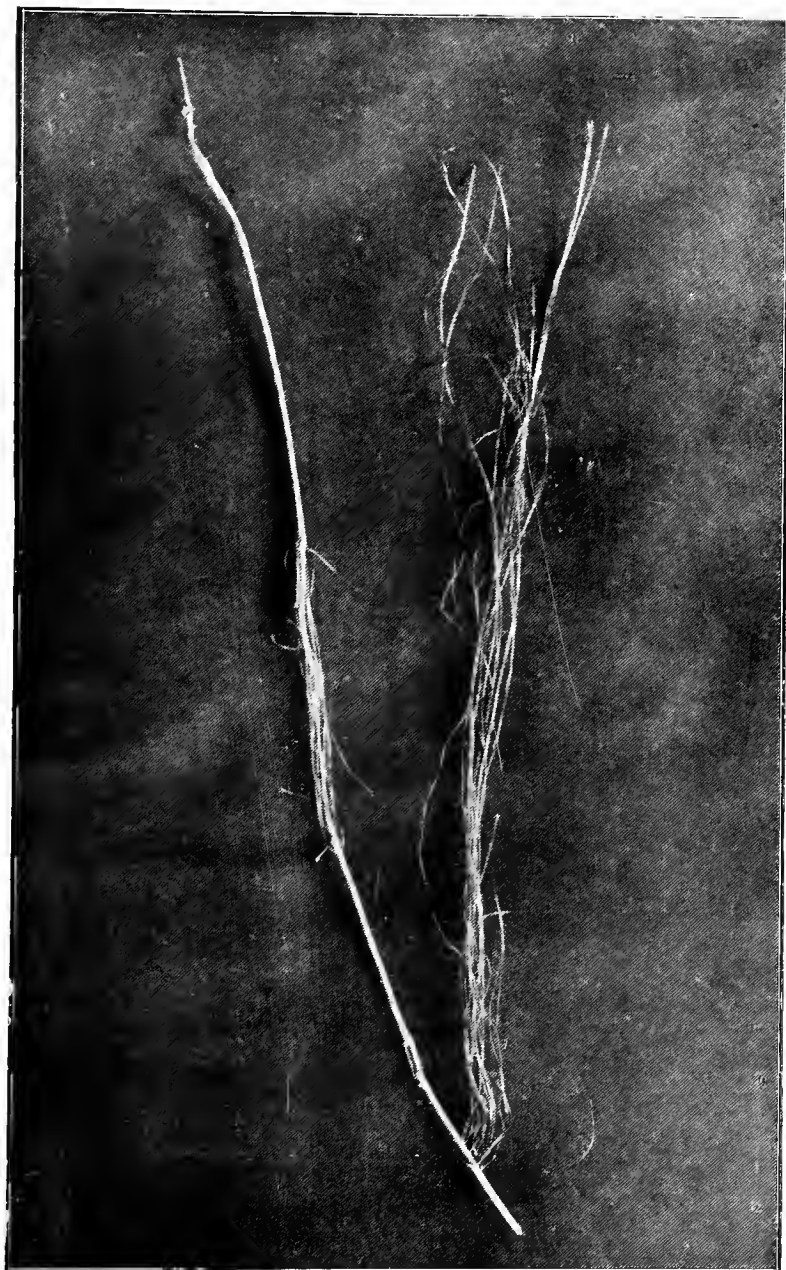


FIG. 2

LOCATION AND RELATION OF THE FLAX FIBRES
TO THE STEM

preparing or drawing and spinning sub-divide these fibre bundles into their ultimate lengths and units of refinement, cohesively and uniformly into a continuous thread which possesses considerable tensile strength. For reasons of economy, the flax spinner treats the flax as though it were a long fibre until the final operation of spinning is reached. In flax spinning the finer and medium sorts are spun *wet*. The rove is conducted through a trough of hot water to the drawing rollers. The hot water sufficiently macerates the pectose to enable the fibres to separate into their ultimate lengths and fineness and to readily pass each other as they are drawn between the two pairs of rollers to be manipulated into the desired mechanical and uniform order and relative fineness.

6. *Flax Fibre Characteristics*.—The chief characteristics of flax fibres are artificial lengths and fineness of ultimate fibres, great strength, inelasticity and remarkable durability.

The goods made from flax are, like the parent fibres, characterised by the relative great strength and power to absorb and give off moisture more readily than its contemporary cotton. Linen fabrics are easy to wash, possess a characteristic gloss which is unequalled; some given types of linen towels possess exceptional drying properties.

7. *Ultimate Fibre*.—The ultimate flax fibre is a long straight tube, the lumen of which is very small; the fibre is intersected at regular intervals by nodes or knots and the surface is characteristically distinguished by cross lines or markings. The cell wall is regularly built up and of uniform thickness and the narrow lumen or internal channel and structures are very difficult to distinguish. The fibre tapers towards the ends and vanishes almost to zero if sufficiently retted.

8. *Chemical Composition of Flax Fibres*.—The chief chemical constituent of flax fibre is cellulose—a compound of carbon, hydrogen, and oxygen, and usually expressed by the well-known formula, $C_6H_{10}O_5$.

The flax fibres, of which about 70 or 80 per cent is pure

cellulose, the remainder being pectic bodies, waxes, and fatty matter, are held together by pectinous compounds.

The flax fibre is frequently classified as a pectic cellulose body. The foreign and non-cellulosic constituents are soluble in boiling alkaline solutions. A boiling of 1 to 2 per cent. solution will extract all the pectic compounds. The pure cellulose remaining cannot then be differentiated chemically from the cellulose of the cotton fibre. The chemical tests for flax are only useful when the natural impurities are present. The infallible test for distinguishing cotton and flax is largely mechanical—the use of the microscope.

CHAPTER II

FLAX SEED

9.—Fibre Seed for Sowing. 10.—Germination. 11.—Weight. 12.—Purity. 13.—Relative Sowing Value. 14.—Testing Flax Seed for Germination Value. 15.—Testing Flax Seed for Weight. 16.—Testing Flax Seed for Moisture. 17.—Testing for Moisture in Hot Air. 18.—Sources of Supply and Varieties of Seed. 19.—Russian Seed. 20.—Dutch Seed. 21.—The Sources of Supply of Flax Seed.

THE seed or fruit product of the flax plant, as previously explained, may be cultivated for subsequent sowings and propagation of its species or for the preparation of linseed oil and feeding stuffs for cattle, etc.

9. *Fibre Seed for Sowing*.—When the plant is grown for its fibre, it is vitally essential that the best available flax seed on the market be selected, since it is fundamentally impossible to grow good flax fibre from indifferent seed. Flax seed of good quality possesses vitality; it is heavy in weight, uniform in pickle, plump in body, smooth and slippery in handle, glossy and brownish in appearance.

The flax seed should be well cleaned by screening, and free from grass and weed seeds and dirt. A sieve containing twelve bars to the inch should be used for the separation of the grass and other small seeds.

Seed merchants of long experience have discovered the most suitable kind of seed for any given climate and soil. To them the pedigree of the seed is always known, hence they are naturally able to satisfy the requirements of any professional or less experienced buyer.

10. *Germination*.—Germination is the beginning of growth in the seed. The *vitality* or high percentage property of germination is the first and most important factor governing the relative value of any seed, since without life in the seed there can be no further propagation of the parent plant. The

ascertained or known percentage of germination is not, however, any conclusive evidence that the seed is either good or bad for fibre production, but it is the pre-eminent factor for ascertaining the quantity which should be sown to each statute acre or other unit area for any prepared or known kind of land.

11. *Weight*.—The second and essential factor of flax fibre seed is its *weight*—absolute and relative. The former should not be less than 4.2 grammes or 65 grains (avoirdupois) per 1,000 pickles.

On the Continent, flax seedsmen of good repute usually reject, for fibre-producing purposes, all flax seed which weighs less than 4 grammes per 1,000 pickles.

The individual pickles in each bag of clean flax seed should, as far as possible, be of the same relative and uniform weight, if a uniform braird and subsequent crop of flax plant and fibre is to be the result. The smaller and lighter pickles should be extracted during the process of cleaning the seed.

Uniformity in the length of the flax straw and the quality of the flax fibre is due more to the foregoing factor than perhaps any other, when once the proper selection of land and preparation of same have received their due share of attention.

When the relative weight of the individual pickles of seed is uniform and the absolute weight of 1,000 pickles is 4.2 grammes or more, then the weight of flax seed should be about 54 lb. per bushel or 189 lb. per bag of $3\frac{1}{2}$ bushels. It is advisable to note that the absolute weight of small seed is relatively greater per bushel or bag than for large seed of like dryness or condition of moisture—a fact which may, consequently, be somewhat misleading as to its correct relative value, and relative sowing quantity.

The absolute weight of flax seed should be definitely ascertained for some given or *known standard condition of moisture*; in other words the cleaned flax seed must be of such dryness that it will not germinate during its period in the store or transit. Air-dried flax seed contains from 10 to 10.25 per

cent. of moisture. A given quantity of air-dried flax seed in capsules, germinated 100 per cent. five months after pulling. (See Fig. 42.)

12. *Purity*.—The purity of flax or other seed is represented by its known or ascertained percentage of pickles in any given quantity of the specified seed, and this is easily obtained by counting off all the flax or other specified seed present in any given quantity

EXAMPLE 1.—In a given quantity of 300 seeds, say, 24 are grass, weed or other foreign seeds, and broken flax seeds. Then the percentage of impurity would be—

$$\frac{24 \times 100}{1 \times 300} = 8\% \text{ and } \therefore 92\% \text{ purity.}$$

13. *Relative Sowing Value*.—The relative value of flax seed for sowing purposes is a compound of the product of its germination and purity, *e.g.*, if the germination is 80 per cent. and the purity of the seed is 92 per cent., then the relative value of the given seed in terms per cent. is equivalent to $\frac{1}{100}$ part of the product, thus—

$$\begin{aligned} & \frac{\% \text{ purity} \times \% \text{ germination}}{100} \\ \therefore \text{Relative value} &= \frac{92 \times 80}{1 \times 100} = 73.6\% \end{aligned}$$

EXAMPLE 2.—A quantity of flax seed germinated 90 per cent. and its purity was also 90 per cent. Ascertain the relative value of this seed—

1. Percentage value of germination

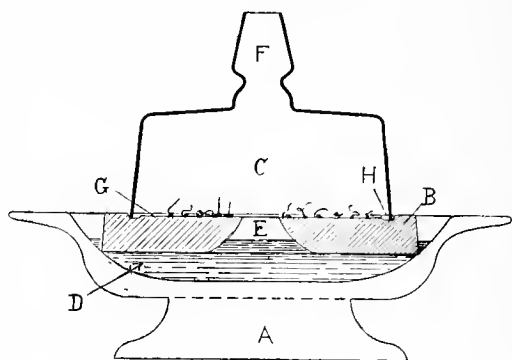
$$= \frac{100}{1} \times \frac{90}{100} = 90\%$$

2. The percentage value when the purity is 90 per cent.

$$\therefore = \frac{90}{1} \times \frac{90}{100} = 81\%$$

14. *Testing Flax Seed for Germination Value*.—This value of flax and other seed is usually expressed in terms per cent.

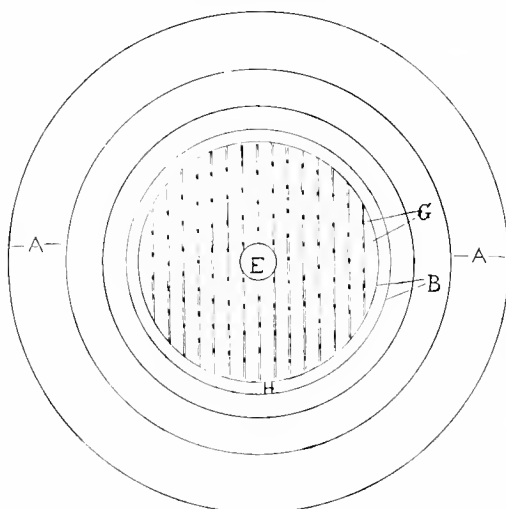
There are numerous methods in use, most of which are simple and primitive, *e.g.*, 100 pickles of seed may be indiscriminately selected and sown into the soil contained in a small box or pot in a room of mild and uniform temperature. Two additional methods are illustrated and described as follows.—



SECTION.

FIG. 7

METHOD I.—This method is simple in design of apparatus,



PLAN

FIG. 8

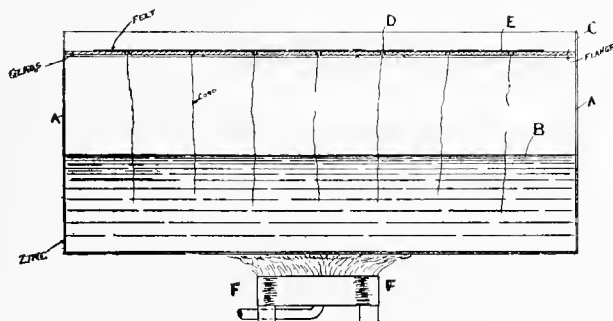
effective in its object and the germination results are readily counted. It is well and fully adapted to meet the requirements of farmers, flax-growers, merchants and other interested people.

Fig. 7 is an elevation and Fig. 8 a plan of the apparatus. The letters in each

diagram refer to corresponding parts of the apparatus.

A is a porcelain dish, B a circular and porous tile having a central core E. C is a glass cover designed with an open

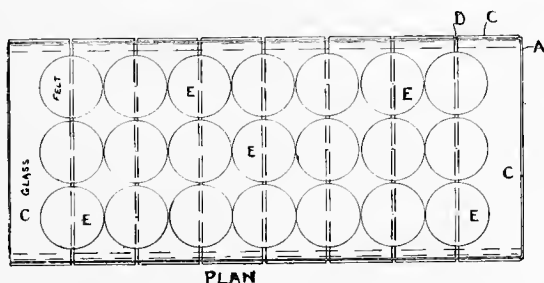
tube or chimney F. This cover fits into a circular groove H on the surface of the porous tile. The tile B is provided with 100 indentations as indicated at G. Into each indent G, one



SECTIONAL ELEVATION.

FIG. 9

seed pickle is laid until the 100 indents are filled indiscriminately from the bulk of the seed offered for sale. Over these the cover C is placed and fitted into the groove H; then the



PLAN

FIG. 10

water D is poured into the dish A until it is almost level with the surface of the tile B. The moisture can freely evaporate through the core E, also circulate in the air within the glass cover C and escape through the chimney F. Obviously the number of seeds which germinate indicates the percentage, and they should germinate within about four days.

METHOD II.—An arrangement of apparatus designed for

the simultaneous testing of several and various lots of seeds is fully illustrated at Figs. 9 and 10.

Fig. 9 shows a sectional elevation and Fig. 10 a plan of same. The letters in each diagram refer to corresponding details.

A is a rectangular zinc trough, designed to hold the water, B. A series of moderately thick glass covers C are adjustably placed over the open part of the trough and a small space D is left between the adjacent glass covers. A series of circular felt cloths E, preferably white, are placed over the contiguous covers marked C. To each piece of felt, two cotton, woollen, or other soft cords are attached and suspended into contact with the water in the trough A. These cords are characterized by their natural affinity for absorbing moisture and conveying it to the felt cloth by which means the latter is kept moist.

Fixed underneath the trough is a gas ring F which, when lighted, warms the water B and accelerates the germination of the seed to be tested. As in Method I, for each test, 100 seeds are chosen indiscriminately from the bulk and placed on the moist surface of any given felt disc. Simple inspection, later, will give the percentage of germination.

15. Testing Flax Seed for Weight.—METHOD I. The bushel measure should be naturally filled to overflowing from the heap of *air-dry* flax seed by means of a shovel, and then a flat rule should be freely drawn across the top so as to remove the excess seed. Flax seed should not be poured directly from a bag into the bushel measure as this method presses the seed more closely together.

METHOD II.—The 1,000 pickles of flax seed, when counted off, should be weighed on a sensitive lever or other simple balance, not necessarily expensive.

As the metric system obtains on the Continent the weight of the seed is expressed in grammes, though grain weights may be used if these only are available. There are 7,000 grains in 1 lb. avoirdupois and 15·432 grains or approximately 15½ grains in 1 gramme.

The following abbreviated table of equivalents will be found useful for reference.

1	gramme = 15.432 grains.	4.1	grammes = 63.271 grains.
2	" = 30.864 "	4.2	" = 64.814 "
3	" = 46.296 "	4.3	" = 66.357 "
3.5	" = 54.012 "	4.4	" = 67.900 "
3.6	" = 55.555 "	4.5	" = 69.444 "
3.7	" = 57.098 "	4.6	" = 70.987 "
3.8	" = 58.641 "	4.7	" = 72.530 "
3.9	" = 60.184 "	4.8	" = 74.073 "
4	" = 61.728 "	5.0	" = 77.160 "

16. Testing Flax Seed for Moisture.—To the average flax grower the problem of accurately testing the flax seed for moisture may appear too technical, nevertheless it is a subject that should be thoroughly understood.

Flax seed, like the flax fibre, yarns, and cloth and other textile materials, possesses the property of absorbing from the atmosphere and of retaining a normal or standard amount of moisture.

As previously intimated air-dried flax seed, when stored in a cool dry room, will retain or naturally absorb 10 to 10.25 per cent. of moisture on the absolute dry weight of flax seed.

When deseeded green or semi-ripe, flax seed should be air-dried for fibre purposes or kiln-dried for feeding stuffs immediately after deseeding, if fermentation or germination is to be avoided.

Small samples or quantities of capsules may be selected from the bulk in store, crushed, and the seed cleaned, weighed, and tested as follows—

17. Testing for Moisture in Hot Air.—This method is simple, effective and expeditious for small and laboratory tests. The apparatus used consists of a small rectangular copper oven ($8\frac{3}{4}'' \times 8\frac{3}{4}'' \times 9$) suitably mounted as to be capable of being heated from a single or double gas ring.

The oven is constructed with an aperture or chimney through which the moisture may escape. It is also adapted to receive a thermometer which may be adjusted so that the temperature of the air in the oven may be read from without, on inspection. The seed to be tested is carefully weighed against grain or

gramme weights. It is then put into a small glass stoppered bottle of known absolute dry weight and from which all the natural moisture has been just previously driven.

The unstoppered bottle, containing the seed, together with the detached stopper, are next placed into the hot air in the oven and the door tightly closed.

The temperature of the air in the oven may be raised to 100° Centigrade or 212° Fahrenheit, though it is better to dry the seed in a slightly lower temperature until all the moisture is driven off, when it will cease to lose weight and be then absolutely dry.

It is then necessary to replace the glass stopper into the bottle and immediately weigh the dry bottle and seed against the selected units of weight. The difference between this weight and that of the dry bottle and untested seed represents the direct loss of moisture from the *seed* from which data the *direct* loss per cent. of moisture may be readily ascertained, or the necessary regain of moisture per cent. to restore the seed to its original weight, and this when compared with the standard or commercial allowance, readily reveals any excess of moisture which the seed contains.

Incidentally, it should be pointed out that any standard commercial allowance of moisture in any textile material must be based on the *absolute dry weight*.

The following actual test was made with apparatus as described above—

Weight of <i>dry</i> bottle and stopper	.	.	= 165 grains
„ seed to be tested	.	.	= 185 „
<hr/>			
„ untested seed and dry bottle	.	.	= 350 „
„ absolute dry seed and bottle	.	.	= 333 „
<hr/>			

Net direct loss of weight of moisture . . = 17 grains

∴ Direct loss of moisture per cent. from the

$$\text{seed} = \frac{17 \times 100}{185} . . . = 9.2\%$$

Also the amount of regain on the absolute dry weight required to restore it to its

$$\text{original weight} = \frac{9.2 \times 100}{90.8} \quad . \quad . \quad . \quad = 10.1\%$$

18. Sources of Supply and Varieties of Seed.—Russia and Holland, until the year 1914, were the two chief countries in the world which grew and prepared flax fibre seed. Irish cultivators of the flax fibre plant, in sympathy with other flax growing countries did not, generally, attempt to save their flax seed for subsequent sowing or exportation.

19. Russian Seed.—The Russian seed was a collection from the numerous flax growing districts in the Baltic provinces of that country. The seed was purchased and sent by dealers to *Riga*. Here it was classified according to colour, size, weight, germination, and purity, and eventually shipped to its respective destinations, under the generic name of *Riga Seed*, the chief variety of which was *Pernau Crown* and which was formerly the most sought after.

Very little authentic knowledge is available of the pedigree and methods adopted for saving and preparing the varieties of Russian seed. It is variously reported that portions of Russian seed are dried by the wind and sun, and that other portions are dried by artificial heat.

The seed should always be subjected to a series of exhaustive tests before purchase or sowing.

20. Dutch Seed.—Holland imports from Russia the bulk of the flax seed which she sows and cultivates. *Riga* seed is first sown in the heavier soils. The seed of this crop is carefully harvested, the bolls crushed, the seed cleaned and denominated “*Riga Child*.”

In the second year a portion of the *Riga Child* seed is sown on lighter soils—the greater balance of this seed is exported. Large quantities come to Ireland and are indiscriminately called “*Dutch Seed*.” The seed saved from the third crop of the original *Riga* seed is classed in Holland as *Riga*

Grandchild, and considerable quantities of this variety are also exported to Ireland.

Holland being geographically much nearer to the British Isles than Russia, the dealers and seed merchants have, obviously, many more opportunities of becoming intimately acquainted with the genealogy and variety of the flax seed offered for sale, and the yield, quality, and fineness of the flax fibre produced in Holland than is possible with Russian productions. Consequently there is always a tendency towards the creation of a higher relative value and the securing of a higher price for Dutch than for Russian seed.

The chief criticism ever made against Dutch seed is, that since it is primarily grown for fibre the resultant seed may be of secondary importance, but it is worthy of note that Holland exercises great care in the harvesting, saving and cleaning of her flax seed.

21. *The sources of supply of flax seed* are now more numerous than prior to the year 1914, or the subsequent Russian revolution. These include English, Irish, Canadian, U.S.A. and Japanese. Experience has proved, and there are many convincing evidences that the seed carefully harvested and prepared from *Irish grown flax* is equal in every quality to any seed which can be imported.

Seed selection for the creation of a good pedigree stock, is usually carried on as follows—

(1) The finest, strongest, longest and best grown flax is selected from a field of growing flax.

(2) The seeds from these plants, after removal and cleaning by the usual methods, are reserved and sown separately in the following year.

(3) The best plants grown from the above selected seeds, are again subjected to a further selection, based on the assumption that these will be the most capable of resisting attacks of weather or insects.

(4) See also paragraphs 11 and 90.

CHAPTER III

CLIMATE AND SOIL

22.—Climatic Conditions. 23.—Soil. 24.—Environment and Crop Production. 25.—Variety of Growth due to Differences in Soil. 26.—Variety of Growths on the same Land due to Soil Moisture. 27.—Exhaustion of Soil. 28.—Rotation of Crops.

22. Climatic Conditions.—The natural or climatic conditions under which flax is grown materially influence the growth of woody matter, fibre and seed. A temperate and equable climate free from heavy rains and frost, interspersed with frequent moist winds, as when near the sea coast, are desirable factors.

Flax seed, sown on well-prepared soil, about the end of April, followed by a showery May, rapidly germinates. The growth of the plant is *uniformly* continuous if the weather during June and the first half of July is warm with occasional showers of rain. Warm dry weather during the remaining days of July and maturing period are the chief climatic factors which materially contribute towards an excellent flax crop.

Atmospheric phenomena should be studied in the locality where it is proposed to grow flax and thus the grower will be able to anticipate and combat every difficulty of weather in such a manner as to produce the very best results under the local circumstances. It may have originally been accidental both in Ireland and on the Continent of Europe, but it is significant, that the location of flax cultivation is generally near to the sea coast, and where the climatic conditions are more equable in temperature and moisture during the flax growing period of the year.

Cool and, other things being equal, moderately moist seasons favour the production of flax which is fine and strong in fibre accompanied with silkiness in handle and appearance. A hot dry summer contributes to the production of a short,

harsh but strong fibre. In hot climates the plant differs materially from that grown in temperate zones. In the former the plant branches out considerably, produces a medium length of straw and quality of fibre and a large quantity of seed.

In the more temperate zones, the straw frequently attains a height of 40 in. with few branchings and seed bolls.

The short hot summers of Russia produce flax of rapid growth, strong in fibre but never of fine quality.

23. Soil.—Soil is the decomposed material of the rock over which it lies.

The chief components of soil are clay, sand, calcareous substances and humus, *i.e.*, decomposed vegetable matter.

The chief constituents of clay are silica and aluminium. Its chief characteristics are tenacity, retention of water and coldness. Sand is destitute of organic matter and plant food, but it forms a useful mixture with clay by improving its texture, facilitating the circulation of air and the addition of warmth. The calcareous substances include chalk and lime which, though deficient in organic matter, sweeten sour soils by neutralizing the acids.

If the soil, at or near the surface, is all pure clay it is termed *cold*.

Heavy soil is so denominated when it contains over 50 per cent. of pure clay.

A *loamy* soil is free and open ; it contains from 25 to 30 per cent. of pure clay.

A *sandy loam* contains 10 to 24 per cent. of clay and a *sandy* soil about 6 to 9 per cent. of clay.

Calcareous soils contain 20 per cent. or more of chalk or lime.

A good soil contains 70 to 75 per cent. of clay and sand in approximately equal proportions and the balance in calcareous substances and humus of approximate equal quantities. It is healthy, well drained, free from weeds, surface and stagnant water.

When cultivated by growers who exercise judgment, science,

and care, the flax plant will grow in any humid climate and in a considerable variety of soils, providing they are not too heavy nor too light. The conclusions gathered from many and varied experiences are that the flax plant readily adapts itself to the different soils, climate and environment. It should be noted that good crops of flax have been grown on light soils of a sandy nature. Many of the best Irish crops of flax have been raised on soils of this nature. A student of soils and of general farming crops contends that a rich light soil is best suited for flax. Experience and observations have frequently proved that a good loamy soil, ploughed 6 or 7 in. deep over a firm clay sub-soil, is ideal for a flax crop. On such soils several excellent crops of flax were recently produced. If the sub-soil does not naturally drain off the surplus moisture, the damp field should be well drained because flax is never satisfactorily grown in water-logged soils. Ideally, the soil and conditions should be such that the moisture readily percolates in wet weather and is freely absorbed from the lower strata in dry weather.

24. *Environment and Crop Production.*—The foregoing factors are capable of producing very considerable changes in the growth, quality, length, strength, elasticity, silkiness, harshness and colour of the fibre, but scarcely to the extent that some experimenters assert.

All crops are affected by their environment, *e.g.*, white blossom flax (*Linum usitatissimum, album*), frequently grown on the heavy soils of Friesland, yields a flax plant which is stronger and coarser than the blue blossom (*vulgare*) plant. “When this seed was sown in South Holland it produced a class of seed that the best judges could not distinguish from ‘Blue blossom.’” Nevertheless the farmers of South Holland will not sow the “white blossom” variety whenever the “blue blossom” is procurable. .

Alluvial soils and re-claimed foreshore lands are reputed to favour the production of excellent crops when sown with seed saved from the blue flowered plants. Generally speaking,

the blue variety yields a finer and better quality of fibre than the white variety, but the latter produces a stronger crop of flax and is less liable to disease than its contemporary variety.

A change of seed and soil is persistently advocated by many flax farmers who claim advantages in quality and yield as a result.

It is significant that many flax growers seldom, if ever, change their seed for the same land and soil. In some of the Baltic provinces of Russia, reputed growers of flax fibre and seed sow their own saved seed repeatedly on their own land. The same is true of flax growers in Friesland.

Many Dutch and Flemish farmers maintain that the flax plant rapidly deteriorates, after a few years in the same soil and even assert that the Riga blue flowering plant changes into the white variety. It is difficult to perceive how the soil could have such an effect on the plant as to change the variety from *vulgare* to *album*. It is more probable that this change is the result of the cross-fertilizing action of the bees extending over a period of years. In the milder climates the flax plant is cultivated for *seed* to be used as feeding stuffs, but when this seed is transferred to a more northerly and colder climate it produces a plant, after a few years of careful cultivation, which reverts to a *fibre*-producing type.

On the suitability of soils, as on almost every other section of flax culture and preparation, diversified views are held. It frequently occurs that some experimentists have only made one series of tests, and consequently their knowledge, though true to fact, locally, may differ essentially from that of others whose experience has been gained in a wider field and different set of conditions. The kind of soil most suitable for flax culture, opens up a large field for thought, observation, and careful investigation.

25. *Variety of Growth due to Differences in Soil.*—In the spring of the present year some Canadian-saved Dutch flax fibre seed was sown on a moderately heavy loam on a clay sub-soil. During the operation some of the seed was

scattered on to a heap of decayed weeds and soil contiguous to a narrow footpath bordering the prepared field, and also 7 to 8 ft. from the hedge bordering the eastern side of the land. The prepared ground adjacent was somewhat heavy and damp, even more so than the rest of the field, and the seed which fell in this part germinated quickly and eventually produced a moderate length of flax straw and fibre, though somewhat below the average of the crop. The seed which fell by accident amongst the decayed vegetation developed later than the main crop owing to this portion of the ground being much drier than the actually prepared part of the field. When the rain fell, ten days later, however, the young plants soon made their appearance and grew very rapidly until the time of pulling and then averaged more than twice the diameter and bulk of that grown in the field proper. It should, however, be noted that long thick and strong flax straw is very frequently characterised by an increase in woody matter, rather than fibre. The foregoing and apparently excessive increase in the diameter of the flax plant was undoubtedly due to the fact that the heap of decayed weeds and soil contained a large amount of decaying, organic, and nitrogenous matter which resulted in a relatively greater production of woody matter than fibre. The application of phosphatic manures would neutralize the excessive action of the nitrogen present in soils of this kind. The resultant and very desirable effect would be an increase in the yield of fibre.

26. *Variety of Growths on the same Land due to Soil Moisture.*—Mr. R. Verner (T. and J. M'Ervel, Ltd., Belfast), on the 22nd April, sowed in a given field, flax seed of a good quality and all uniform in "pickle." The soil was well prepared, but, like most other lands, it varied in solidity, natural moisture, and local drainage. The weather at the time of sowing and for twelve days afterwards, was dry, consequently the germination of the seed depended primarily upon the amount of moisture retained by the soil. This point is very forcibly illustrated at Fig. 11 which is a half-size reproduction of the

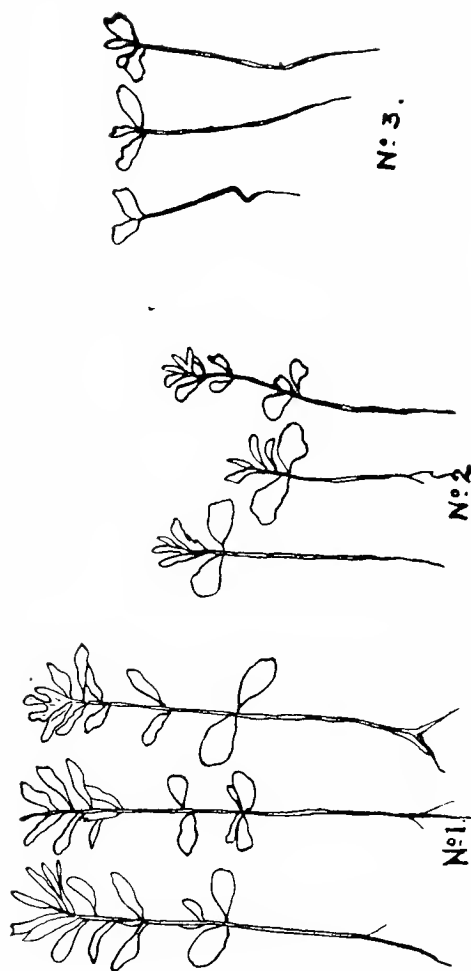


FIG. 11

YOUNG FLAX PLANTS GROWN FROM LIKE SEED AND ON THE SAME FIELD—LENGTH
OF BRAIDS MODIFIED BY STATE OF THE SOIL AND MOISTURE.

three groups of flax "brairds" (young plants) which had been simultaneously extracted in May.

Group I was evidently grown in soil sufficiently moist and warm to start immediate germination.

Group II. The pickles reached a greater depth in a less

Nitrogen.	Phosphoric Acid.	Potash.	Lime.	Silica.	Ash
					210
					Wheat

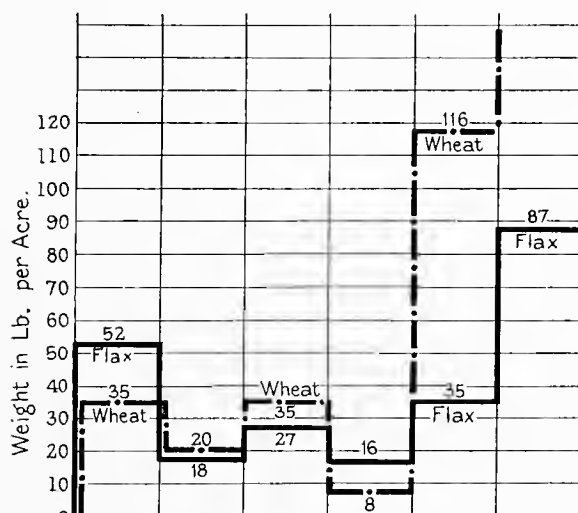


FIG. 12

FLAX AND WHEAT

Comparisons of extractions from the soil of nutritive properties in lb. per acre of cultivation.

moist soil, hence the resultant germination and brairding were later than No. 1 group.

Group III. The pickles fell into dry ground and consequently were preserved until the rain began to descend twelve days later.

The knowledge of the foregoing facts is most important because experts have been known to declare that the variation in the brairds is due to different grades or classes of seed having got mixed.

27. *Exhaustion of Soil.*—Pliny asserts that the flax plant has the property of scorching (exhausting) the ground where it grows and of deteriorating the very soil itself. Among present-day farmers this view still prevails; moreover, they hold that the flax plant removes from the soil a greater proportion of nutriment than occurs with other farm crops; on the contrary, the researches of scientists and experimenters conflict with this deeply-rooted belief. Farmers, however, are not easily diverted from ordinary custom, they are naturally shy and sceptical, they are a cautious people and adhere tenaciously to traditional ways of supposed success reaching back through many decades and generations. They shun new ideas and suggested modifications and improvements either of methods or material when initiated by theorists.

Scientists who have investigated this phase of the subject contend that a field sown with flax seed does not lose any more of its nutritive properties than does a like field of soil sown with wheat, barley or other cereals.

Fig. 12 is a graph prepared from the research records of Professor Snyder, demonstrating the truth of this contention. The graph is a comparison of flax and wheat, and shows relatively the extraction of nutriment taken from the soil per acre of cultivation. A study of the illustration shows that the flax extractions from the soil were, in two cases only, in excess of the wheat extractions and these were comparatively slight.

Fig. 13 is a graph specially prepared to show the extraction from the soil of potash, nitrogen, and phosphoric acid—three essential constituents of the flax plant. It will be noted that the extraction by the flax plant compares favourably with the six other farm crops represented. A perusal of the illustration demonstrates that flax may follow any crop except turnips and mangel wurzels.

28. Rotation of Crops.—The rotation of crops is practised with the object of utilizing the natural productiveness of the soil to its fullest advantage and avoid impoverishing the land

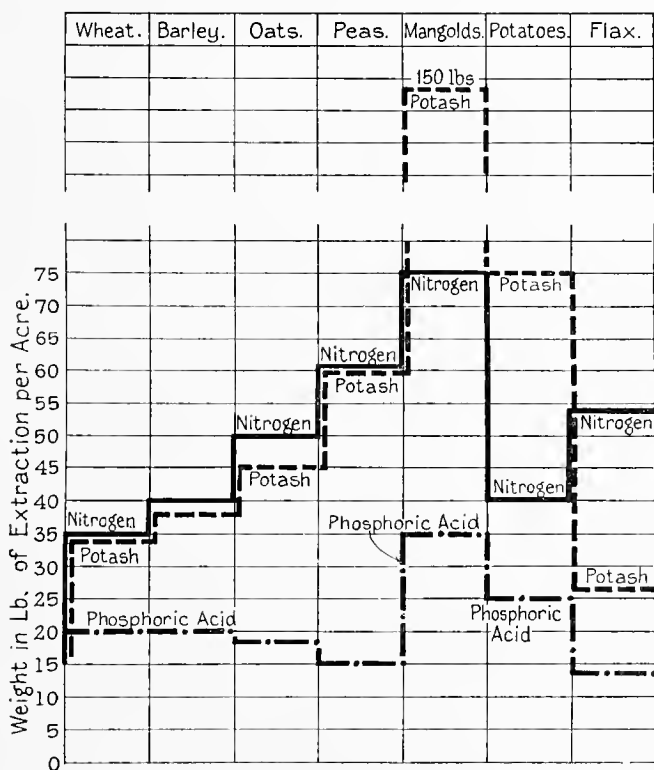


FIG. 13

FLAX AND OTHER FARM CROPS

A comparison of extraction from the soil of Nitrogen, Potash and Phosphoric Acid—three essential constituents of the flax plant.

too much of any specific plant food. It is economical and also simplifies the problem of manuring

Various orders of rotation are practised by different farmers and flax growers in each country. In Ireland it is customary to sow flax in the year of rotation following a crop of oats or potatoes, but preferably a corn crop and never turnips.

Many growers of flax have recently discovered that a good crop of flax can be grown on lea ground, which is rich in plant food, without the application of manure or fertilizers.

The following series of rotations are typical examples, where flax is included, and have been proved to be satisfactory.

Years.	A.	B.	C.	D.	E.	F.
1	Potatoes	Rye	Oats	Rye	Turnips	Barley
2	Flax	Oats	Flax	Potatoes	Oats	Rye
3	Clover	Clover	Potatoes	Oats	Potatoes	Oats
4	and	Barley	Oats*	Clover	Flax	Clover
5	Grass	Potatoes	Hay	Clover	Beet	Potatoes
6	Oats	Rye	Grass	Wheat	Oats	{ Barley Wheat or Rye Flax
7	Potatoes	Flax	Grass	Flax	Clover	
8	Flax					

* Grass seed or clover is sown with the oats so as to ensure that a crop of hay can be taken from the field in the following year. The rotation, C, is an ideal Irish system.

CHAPTER IV

MANURES

29.—Plant Foods. 30.—Artificial Manures. 31.—Properties of Artificial Manures. 32.—Nitrate of Soda. 33.—Muriate of Potash. 34.—Phosphatic Fertilizers. 35.—Fresh Stable Manures. 36.—Belgium and Holland. 37.—Manurial Experiments.

29. Plant Foods.—A manure is any substance containing plant food which, when incorporated with the soil, decomposes and takes such a form that it can be readily assimilated by the plants.

Most soils are generally well supplied with plant food, but not always in a soluble condition. Changes of weather, heat, frost, snow, and rain, together with good cultivation, assist these several foods to dissolve or change until they are in the state capable of being absorbed by the plant.

The three essential plant foods in most fertile soils are nitrogen, phosphoric acid, and potash. One or other of these is occasionally and temporarily exhausted. Any one may be restored to the soil again, but the farmer must exercise careful observation to ascertain which kind is required.

Occasionally lime is applied as a developer of the natural plant food contained in heavy soils. "Fallen" lime is a deliquescent. It readily absorbs moisture, dissolves acids, opens up the soil and improves its texture; it decomposes decaying vegetable matter, which, in the process, generates heat to the soil and simultaneously produces carbonic acid and ammonia, both important plant foods.

It is for each farmer to ascertain the specific food manures requisite for the sustenance of flax on his own particular soils. At the present time it is possible to learn, from various sources, how to act precisely in each specific case.

30. Artificial Manures.—Artificial and chemical manures are used because they contain plant food which is in a state

that can be readily absorbed by the growing plants. Such fertilizers are usually classified, nitrogenous, phosphatic, and potassic.

Nitrate of soda—a Chili deposit—contains over 90 per cent. of sodium nitrate. Pure nitrate contains from 15 to 16 per cent. of nitrogen and is a highly soluble substance which is frequently used as a top dressing for growing crops and after dung and potassic manures.

Phosphatic and potassic manures are chiefly derived from bones, dried blood and other animal fertilizers. Their action is slow, but when dissolved with sulphuric acid, they are reduced into a more active condition and are more readily absorbed by the plants. Bones thus dissolved are denominated acid superphosphates.

Basic Slag, containing 15 to 18 per cent. of phosphoric acid and 50 to 60 per cent. of lime, is most suitable for sour and peaty soils and those deficient in lime or rich in organic matter.

Seaweed contains large quantities of lime and small quantities of potash and phosphoric acid.

31. *Properties of Artificial Manures.*—The additional artificial manures and some of their properties will be found useful classified as follows in terms per cent.—

Artificial Manure.	Organic. Matter.	Water.	Nitrogen	Phosphoric Acid.	Lime.	Potash.
Nitrate of Soda .	—	1·9	15·6	—	·2	—
Basic Slag .	—	—	—	17·9	58·5	—
Kainite .	—	12·8	—	—	1·1	13·8
Sulph. Ammonia	—	4·	20	—	·5	—
Bone Meal .	30	6·	3·8	23·2	31·3	·2
Acid Super Phosphates .	24	13·	2·5 1·5 to 3·5	14·7 —	— 3 to 4	—
Soot, Wood .	70	5-6				

A flax crop is usually grown without any added manure. Many flax growers of long experience and considerable repute have declared that they never manure the land when preparing it for a crop of flax ; their arguments *re* same are chiefly

based on the fact that they have been very successful in securing good results without ever resorting to the use of manures.

Much better results are obtained by a generous treatment of the soil during the period of crop rotation than by the direct application of manures for the flax crop.

Notwithstanding the deep-rooted idea that flax is a non-manurial crop, numerous trials and experiments *re* manuring or otherwise, have been carried out both for educational and commercial purposes.

Under favourable conditions of weather and soil the flax seed germinates rapidly and the growth of the flax plant is of comparatively short duration. Pliny, in his writings, asserts that there is no vegetable production that grows with greater facility. There are, however, many known vegetables of more rapid growth. Generally the flax plant reaches the limit of its growth in about nine or ten weeks, at which stage "the lint is in the bell," (see Frontispiece). Soon after the seed begins to form and the fibre to mature until the time of pulling, which is usually thirteen weeks.

The ideal flax plant develops at a uniform rate, any deviation from this desired regularity of growth correspondingly deteriorates the yield and quality of the resultant fibre.

It is not unreasonable to assume that a knowledge obtained, by either observation or analysis, of the soil, its possibilities and deficiencies, together with a judicious application of manures to neutralize these deficiencies, is the factor that will materially contribute towards the desideratum of the equable and continuous growth of the flax plant.

The application of fertilizers containing only one element of plant food at or before sowing time, or as a top dressing, should only be given when the user has come to a complete understanding with regard to the requirements of the particular soil with which he is dealing, otherwise these applications are seldom successful.

32. *Nitrate of Soda*.—This gives the young plants a start in dry weather and so obviates the natural and harmful tendency

of the plant to remain stagnant after germination, but the application finally results in the production of a weaker fibre.

33. *Muriate of Potash*.—This has frequently been tried with flax crops and has met with a fair measure of success. The plant rapidly assimilates this kind of nourishment, most probably because the potash in this form is readily soluble in water.

34. *Phosphatic Fertilizers*.—These produce a coarser and stronger straw but fibre of less relative yield. They are better applied to counteract the excessive action of nitrogen.

35. *Fresh Stable Manures*.—When used these should be ploughed into the soil during the rotation of the crop preceding the flax crop. If ploughed in during the preparation of the ground for the flax crop, it introduces foreign seeds, resulting in a large increase of weeds, and though it increases the growth of the flax plant, there is not the same corresponding increase of fibre.

During the various experiments conducted by the Department of Agriculture and Technical Instruction for Ireland, and others, it has been found that a complete manure usually gives the best results. The proportions per acre are made up as follows: $\frac{1}{2}$ cwt. sulphate ammonia, $\frac{3}{4}$ cwt. muriate of potash or 3 cwt. kainit and 3 cwt. superphosphate. The muriate of potash should be used where possible.

On soils overstocked with organic matter and producing luxuriant growth, the sulphate of ammonia should be withheld. On some soils the application of $1\frac{1}{2}$ cwt. of muriate of potash will alone suffice to give a good return. The observation of the individual farmer of his own land will prove most beneficial in this respect.

It is a good thing to cart all the liquid manures and sewage on to the field during the period of rotation.

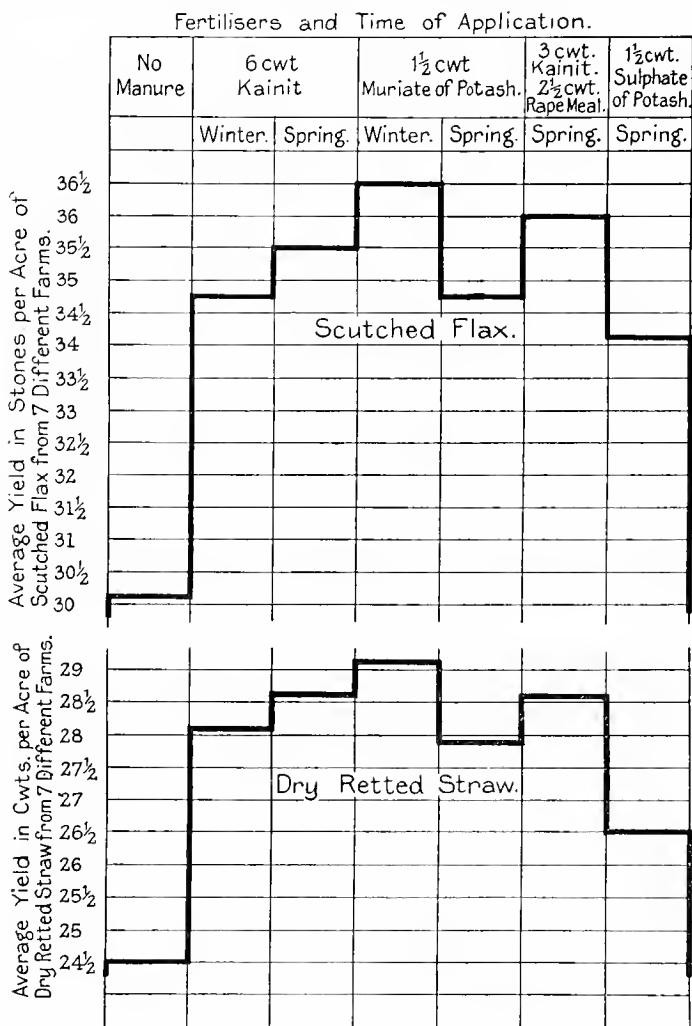
36. *Belgium and Holland*.—In Belgium the manuring of the rotation crops is as thorough as that performed for garden plots and culture. Heavy dressings of manure are applied

to the crop immediately preceding the flax crop. Liquid manures are applied during the preparation of the land a few weeks before the flax seed is sown, but this procedure is open to criticism. The use of chemical manures does not find much favour and is seldom practised. In Holland the rotation crops are only manured two or three times during the period of rotation, but a second green crop of clover is sometimes ploughed into the land in lieu of manure. Generally the soil is moderately heavy, moist, well-drained and readily porous so that it probably does not require the same amount of fertilizers as does the land in Belgium.

37. *Manurial Experiments*.—Mr. F. K. Jackson, Flax Experimental Station, Selby, observes that “In the trials of artificial manures perhaps the clearest and most decisive results have been those following the application of a soluble nitrogenous manure, notably sulphate of ammonia, at sowing time, and at the rate of 1 cwt. per acre. Each year the increase, both in the weight of unthreshed straw and in the resultant seed and fibre, has been very marked, while, in addition, the quality of the fibre was improved. Potash was used but gave no such marked increases as the nitrogenous manures. This is probably due to most of our flax being grown on land tending towards heaviness and therefore probably already well supplied with potash. Superphosphate has given no clear indications of value, but there has not been the tendency to favour weeds which was so marked a feature of its use in Ireland in the Department’s experiments.

Mr. W. J. Megaw (Department of Agriculture and Technical Instruction, Ireland), commenting on results obtained in experiments carried out in Ulster by the Department of Agriculture, on the manuring of flax, states that they differ materially from those obtained in the trials at Selby. Whilst in the Department’s trials a dressing of sulphate of ammonia proved remunerative, much better results were obtained from the use of potash manures. In most seasons, however, a combined dressing of sulphate of ammonia and muriate of potash was

more profitable than either of these manures applied singly. The treatment which perhaps proved most beneficial of all



FIGS. 14 AND 15

in the Irish trials consisted of liming the land one year in advance as a preparation for the flax crop, and then applying

a dressing of muriate of potash at the time of sowing the flax. The good effect of potash manures appeared to be largely due to their action in preventing the flax brairds from being affected with "yellowing"—a disease which seriously retarded the growth of the young flax plants and which was very

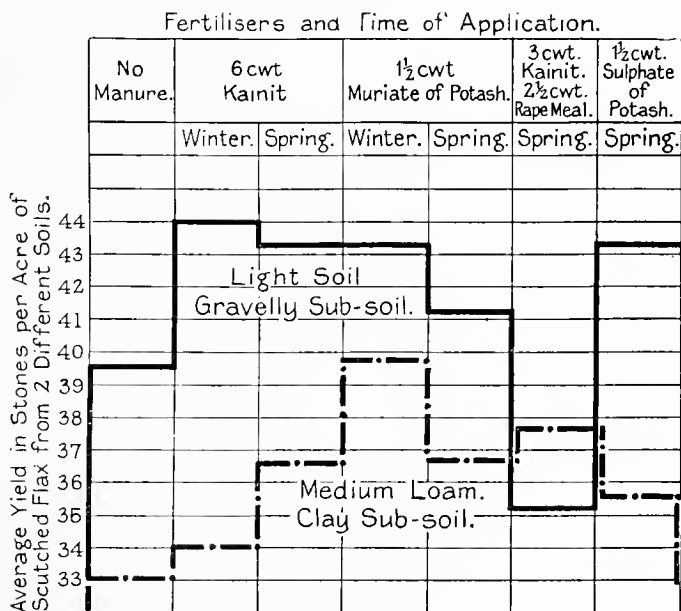


FIG. 16

common in Ulster. Some years ago, flax buyers had a strong prejudice against the use of chemical manures for the flax crop, as they considered such dressings lowered the quality of the fibre. It was, however, now well recognized that the use of potash manures, or of light dressings of sulphate of ammonia, tended to improve this fibre, and this was borne out by the values placed by skilled flax buyers on the various lots of flax from the Department's experiments.

Obviously, the nature and quality of the soil combined with the constituents of the flax plant are the prime factors for determining the necessity of manure or fertilizer, quantity and

period of application. The influence on the yield of flax straw and fibre by the application of different kinds of manures and fertilizers is illustrated by the graphs at Figs. 14, 15 and 16, which have been prepared from the official records of manurial experiments connected with the preparation and growth of flax as conducted by the Department of Agriculture and Technical Instruction for Ireland.

Figs. 14 and 15 represent the average yield per acre of flax straw and fibre from seven like plots, each on nine different farms. The characteristics and class of soil on the nine farms were as follows—

On 3 farms, medium loam—clay subsoil.

„ 2 „ heavy loam — „ „

„ 2 „ light loam —gravelly subsoil.

„ 1 „ medium loam—sandy „

„ 1 „ peaty top —light clay „

Fig. 16 shows the manurial results averaged for the like plots on the three farms where the loam was of medium tilth with a clay subsoil. It also shows the influence of the various manures on one of the light soils with a gravelly subsoil.

For each application of manure represented by the graphs a slight net increase in profit was realized. The true economist, patriot, and humanitarian is, however, induced by higher motives than that of profit to increase the production of material which, after all, is the chief form of wealth. We are frequently reminded that the habitable globe is now generally occupied and that we must look forward to relatively fewer and more expensive products; land and rents will increase; consequently every application of science and labour which tends to increase production, either of food stuffs or clothing, adds considerably to the material wealth of the race.

CHAPTER V

PREPARATION OF THE LAND

38.—Preparation of the Land. 39.—Conditions of Prepared Soil. 40.—Ploughing and Grubbing. 41.—Harrowing and Rolling. 42.—Methods of Procedure.

38. Preparation of the Land.—Manifestly it is impossible to germinate the comparatively small flax seed in soil which is hard and lumpy without materially reducing the germination percentage of the flax seed.

In the preparation of the land ploughing, cross-ploughing, or alternatively grubbing followed by harrowing and rolling are necessary.

The attention devoted to this section of the work by the cultivator will materially develop most of the food properties that would otherwise lie dormant in the soil. A suitable combination of the above operations should be made and repeated until the ground is thoroughly pulverized into a perfectly fine tilth.

The rapidity of the growth of the flax plant involves a corresponding and *constant* nourishment, otherwise the development of the plant and fibre may be checked. Whenever the plant is erratic in its growth the resultant fibre is irregular and the yield of scutched material is reduced.

39. Conditions of Prepared Soil.—The prepared soil, in addition to being sufficiently fine in texture, must also be *firm* and sufficiently porous to allow of percolation or capillary attraction, and impart strength and stability to the growing plants. If the soil is loose and unstable the stem cannot stand erect nor be able to offer an elastic resistance. When properly worked, the roots of the individual plants penetrate deeply and perpendicularly into the soil and thereby each plant is in a position to receive its maximum food supply within its limited area.

Briefly summarized then—perfect preparation of the soil to a fine, firm and porous tilth is the best guarantee towards a good crop of flax. This is even more important than the soil itself. When the soil has been thoroughly prepared a light covering is all that is necessary to cover the seed. The various operations of preparation and their varied sequence may be detailed as follows—

40. *Ploughing and Grubbing*.—Flax generally requires rather deeper ploughing than most other farm crops. Plough 6 or 7 in. deep in the autumn and cross-plough lighter in the spring is a safe guide to follow. Early ploughing facilitates the after pulverizing of the soil in the spring. Deep pulverization is more important for flax than is usually believed. No crop is less suited to a wet soil than is flax.

Grubbing on heavy and medium soils is sometimes adopted in lieu of cross-ploughing in the spring.

41. *Harrowing and Rolling*.—The function of the harrow, Fig. 17, is to reduce the ploughed and grubbed earth to the smallest particles possible. This operation, together with heavy rolling, must be judiciously combined and repeated until the desired object has been fully and completely attained.

If the soil is not sufficiently broken up by the harrow, then a raft of heavy planks with narrow but strong pieces of wood nailed crosswise on the underside, may be employed to obtain the necessary fineness.

42. *Methods of Procedure*.—Two methods of operations, with their order of sequence, are given herewith—

A. *For a Heavy Loam*—

1. Plough 6 or 7 in. deep in the autumn.
2. Cross-plough in the spring, or grub.
3. Break with a coarse harrow.
4. Give two strokes with spring-harrow.
5. Harrow.
6. Spring-harrow.
7. Chain-harrow.
8. Rake or chain to clean up the weeds and scutch grass.

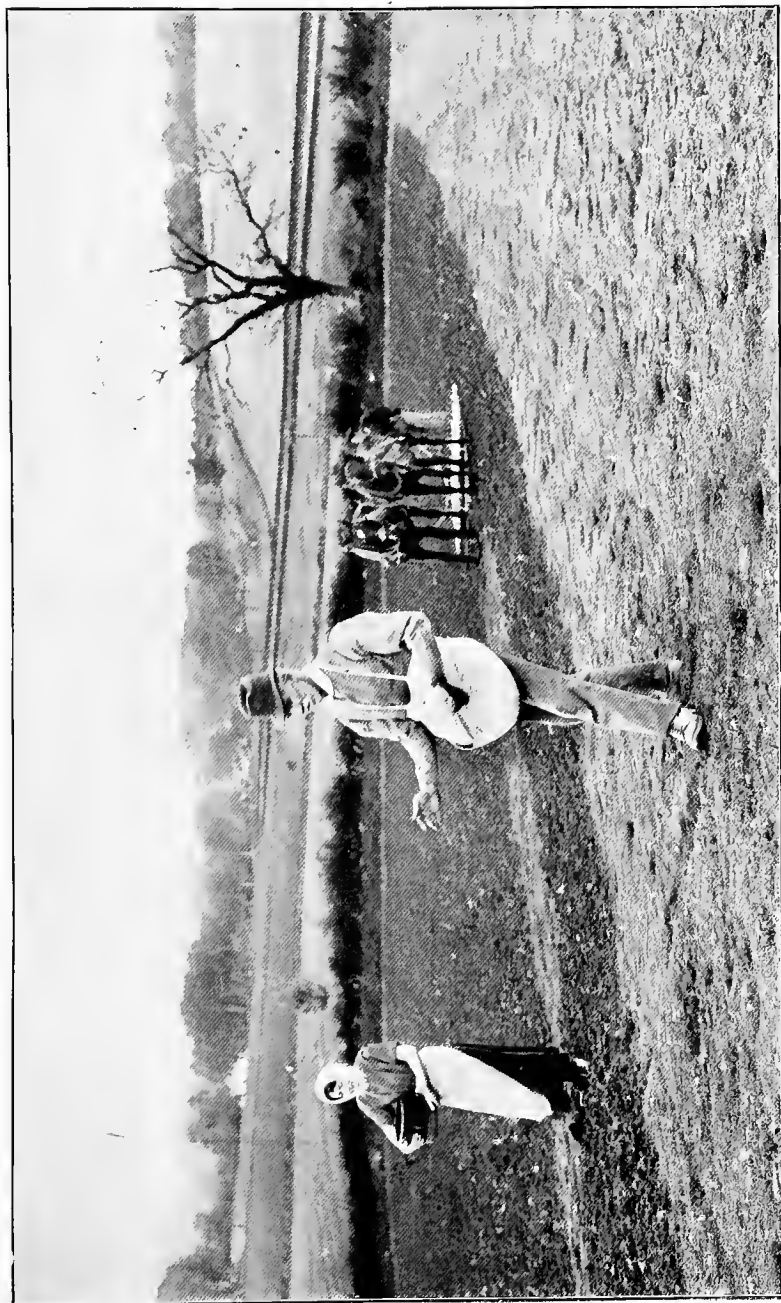


Fig. 17

HARROWING, AND SOWING FLAX BY HAND

9. Roll to consolidate the soil.
10. Fine harrow—two strokes.
11. Sow the seed.
12. Fine harrow—two or three strokes.
13. Roll, to firmly fix the seed.
14. Weed the brairds once or twice as may subsequently be necessary.

B. *Medium Loam, Clay Sub-soil*—

Field sloping gently from west to east and near the sea. The operation and sequence employed were as follows and the resultant crop was very satisfactory.

1. Ploughed 5 to 6 in. deep in February.
2. Harrow —3 strokes. E. and W. direction.
3. Spring-harrow —2 „ N. and S. „
4. Boards (raft) —2 „ N. and S. „
5. Fine harrow —2 „ N. and S. „
6. Loose weeds and stones lifted from the field.
7. Heavy roller. N. and S. direction.
8. Fine harrow. E. and W. „
9. Seed sown with the “ Fiddle.” E. and W. „
10. Fine Harrow. N. and S. „
11. Heavy roller. N. and S. „
12. Weeded once.

If the soil is light in texture—a single ploughing and a few strokes with the harrow is all that is necessary. The soil must, however, be firmly rolled.

CHAPTER VI

SOWING

43.—Period Selected for Sowing. 44.—Early Sowing. 45.—Quantity of Seed per Acre. 46.—Tabulated Sowing Data. 47.—Hand and Machine Sowing. 48.—Details of the “Fiddle.” 49.—Operation of the Mechanism. 50.—The Work of the Sower.

43. Period Selected for Sowing.—The time of sowing depends on the climate and specific locality of the country.

Generally speaking flax seed should be sown as early as possible in the spring to ensure that the germination will occur with regular slowness, since the soil is likely then to be more uniformly moist and cool than later in the season. Early sowing makes possible the tempting prospect of early pulling and thereby affords a better chance of harvesting the crop before the bad weather arrives. The most exemplary illustration on this point occurred recently. Several flax growers sowed their seed about the middle of April; the crop was ready for pulling in the second week of July and consequently the bulk of these crops was pulled, retted and dried and the balance reserved for deseeding was also dried and stacked early in September, when the exceptionally inclement weather commenced and continued, more or less severe throughout the autumn months. Many other growers who sowed their seed at the end of April or the beginning of May were unfortunately pulling, steeping, and endeavouring to dry the straw during the many weeks of almost incessant rain which commenced early in September. The resultant effect was that many crops were almost completely lost while others were seriously deteriorated in quality and yield of fibre.

44. Early Sowing.—On the other hand, early sown crops are liable to grow up with a greater quantity of weeds than do those of later sowings. Singularly enough some of the earlier

sown crops last year were attacked with a small beetle or other insect which did much damage and in some instances involved a second sowing which the later sowing avoided. Consequently, the old proverb, "Who soweth too lateward hath seldom good seed; who soweth too early little better shall speed," is suggestive of the difficulty of determining just the right moment for sowing.

The observant farmer is the person who best knows when to sow his flax seed and when the prepared soil is best suited to receive it.

The nature, quality and condition of the soil are factors which govern or favour late or early sowing. If the soil is wet and heavy then sowing at the end of April or early in May is soon enough, but if the soil is sandy, dry and free from clods or lumps, the seed may be sown about the middle of April. Flax growers who intend to put comparatively large areas under cultivation, should sow at suitable intervals from the middle of April to the end of May.

45. *Quantity of Seed per Acre.*—In the heavier soils a greater proportion of seed fails to germinate than in the lighter soils, hence in proportion as the soil is heavy and wet so must the quantity of seed sown be increased as compared with the lighter and drier soils.

There are numerous factors which govern the quantity of seed to be sown; these chiefly include class, purity, and percentage of germination of seed. An important characteristic of the flax plant, and which incidentally influences the proportion of the seed to be sown per acre or other unit, is that when the flax seed is thinly sown the growing plant throws out a considerable number of small branch stems. The resultant effect of such branching, is the production of fibre which is both short and coarse. This form of sowing is, however, productive of a large quantity of seed and is consequently the method adopted whenever flax is grown for seed to be used for feeding purposes. When sown for the *fibre* the seed must be scattered in greater profusion than for reproduction of seed

purposes only. In such cases the flax plants grow up in greater numbers, erect and singularly free from branching; each straight stalk is characterised by a series of small leaves alternating and radiating at intervals from the root to near the top of the stem which carries only a few seed bolls.

In Belgium an average of 2 bushels per acre is sown on light soils. In France, on a loamy soil, about $2\frac{1}{2}$ bushels are sown per acre, and on the reclaimed land (polder) in Holland as much as 3 bushels for the same area.

46. *Tabulated Sowing Data.*—The Department of Agriculture and Technical Instruction for Ireland advise sowing the following quantities of flax seed. The abstract table given herewith is adapted to meet the requirements of the different farmers and flax growers according to their accustomed sowing for known quality of seed, conditions of climate, locality, and previous experience, based on an approximate germination of seed of 95 per cent.

Normal Sowing of Different Growers.		Relative Amount of Seed to be Sown for given Germination.							
		95%	100%	95%	90%	85%	80%	75%	70%
Per Statute Acre.	Pks. Qts.	Pks. Qts.	Pks. Qts.	Pks. Qts.	Pks. Qts.	Pks. Qts.	Pks. Qts.	Pks. Qts.	Pks. Qts.
Grower A	6 4	6 1	6 4	6 7	7 2	7 6	8 2	8 7	8 7
Grower B	7 0	6 5	7 0	7 3	7 7	8 3	8 7	9 4	9 4
Grower C	7 4	7 1	7 4	7 7	8 3	8 7	9 4	10 1	10 1
Per Irish Acre.									
Grower A	10	9 4	10 0	10 4	11 1	11 7	12 5	13 5	
Grower B	11	10 4	11 0	11 5	12 2	13 0	14 0	15 0	
Grower C	12	11 3	12 0	12 5	13 3	14 2	15 2	16 2	

And pro rata for any other germination.

N.B.—One statute acre contains 4,840 sq. yds.

„ Irish „ „ 7,840 „

Statute $5\frac{1}{2} \times 5\frac{1}{2}$ yds. = $30\frac{1}{4}$ sq. yds. = 1 pole or perch.

Irish 7×7 „ = 49 „ = 1 „ „

Then $30\frac{1}{4} \times 40 \times 4$ = 4,840 sq. yds. = 1 statute acre.

and $49 \times 40 \times 4$ = 7,840 „ = 1 Irish acre.

DRY MEASURE OR TABLE OF QUANTITIES.

4 gills = 1 pint; 2 pints = 1 quart.

4 quarts = 1 gallon; 2 gallons = 1 peck.

4 pecks = 1 bushel; $3\frac{1}{2}$ bushels = 1 bag of flax seed.

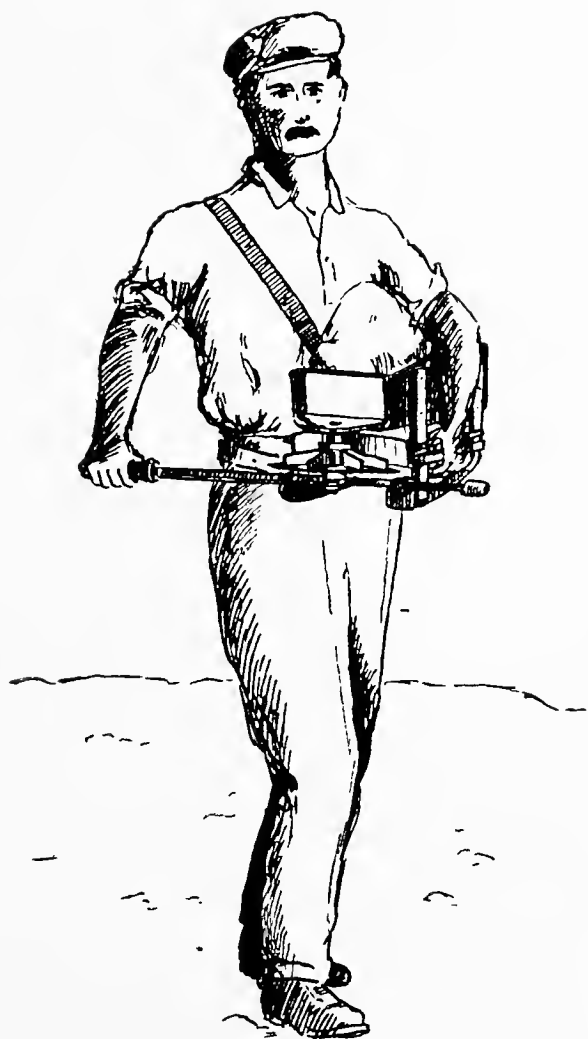


FIG. 18

SOWING THE FLAX SEED WITH THE FIDDLE

OPERATION OF SOWING

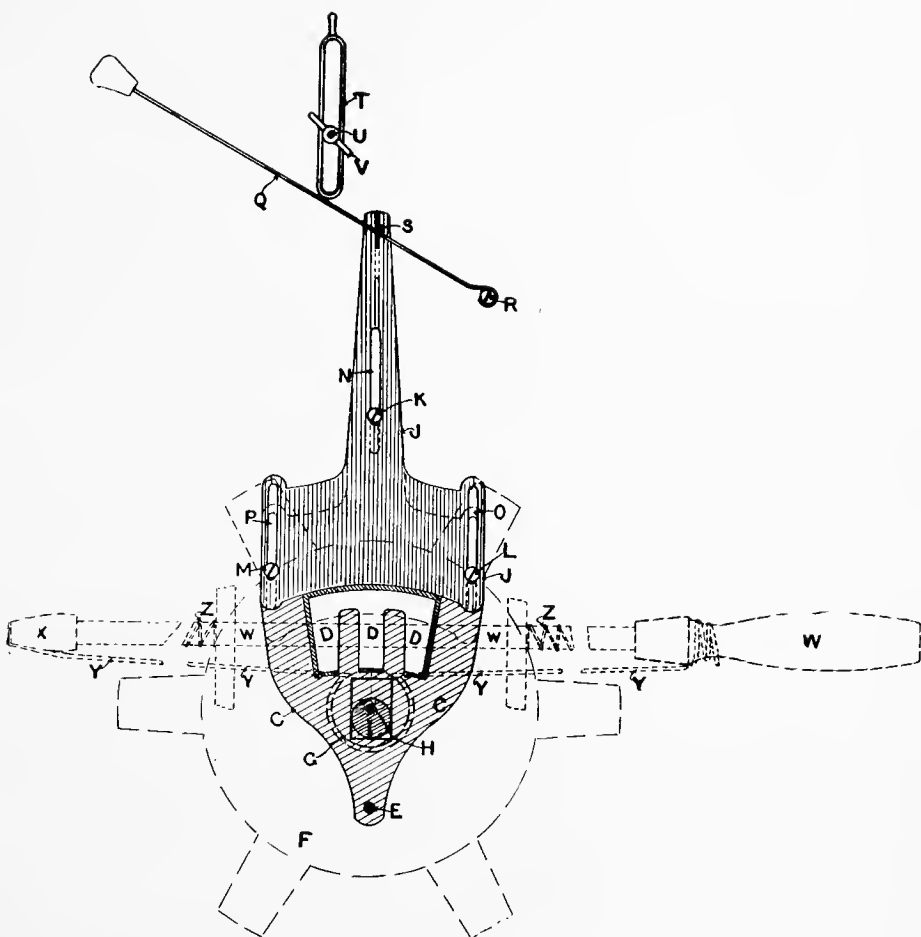
47. *Hand and Machine Sowing.*—From time immemorial the flax seed has been sown broadcast by hand. (See Fig. 17.) Within recent years a small machine denominated a “fiddle” (Fig. 18), has been invented to do the work. In this sketch the nose and distributing fan are shown drawn directly in front of the sower. This is the correct position, when it is desired to distribute the seed equally on either side.

This machine is ingenious, simple and effective and is being increasingly and extensively used. In capable hands it distributes the flax seed regularly and uniformly over a width of 18 to 26 ft. for each traverse of the sower. (See Fig. 22.) By its use the operation of sowing is reduced to simplicity and the irregularities and waste of hand sowing are neutralized.

48. *Details of the “Fiddle.”*—An underside plan view, a sectional elevation and a plan of the distributing wheel are given at Figs. 19, 20, and 21. The same letters in each diagram refer to corresponding details of the machine.

A indicates a portion of the base and supporting frame-work of a box B which is designed to temporarily hold a supply of seed. The sower generally provides for carrying a sufficiency of seed to sow the prepared soil which can be covered by a “to and fro” journey across the field. The amount of seed necessarily varies, but arrangements can be made to increase the quantity to any reasonable extent by simply attaching a tubular piece of canvas to the upper part of the seed box.

An iron plate, C, termed the *feed plate*, with portions cut away as shown at D, is pivoted on the small stud E fixed in the base of the box B. The cut-away portions with their intersecting projections as shown, are designed to allow the seed to fall by gravity but under control from the aperture in the base of the seed box B on to an oscillating hexagonal ribbed wheel F. The wheel F is secured to a small wooden pulley G, in turn compounded with a vertical spindle H.



PLAN FROM BELOW

FIG. 19

Sweated on to the upper end of the spindle H is a small brass collar or pulley I but set out of its centre on the spindle H. This pulley loosely fits into a recessed part on the under-side of the iron plate C. The spindle H passes freely through the wood base A and rests freely and is free to oscillate on an iron plate, fixed as shown, to the underside of the base A. A second plate J, styled the *shut-off plate*, is adjustably supported to the underside of the seed box B by set-screws K, L, M, which pass through the slotted portions N, O, P respectively of the plate J. By this arrangement the shut-off plate J is free to reciprocate in a direction parallel to the base of the feed box B so as to partially or wholly cover the aperture D of the vibratory lever and feed plate C.

A small iron lever Q is pivoted to the underside of the seed box B by the set-screw R, and may be adjusted to any desired position about its pivot stud R. The nearer it is moved towards the front of the feed box the more completely it moves in sympathy with the shut-off plate J and closes over the aperture D and thereby regulates or entirely shuts off the supply of the seed in box B.

The limit of the backward traverse of the lever Q and the shut-off plate J, and incidentally the flow of seed from box B, is controlled by a small bracket T adjusted on the fixed stud U to the underside of the feed box B by a thumb-screw V, as shown at Fig. 19. A fiddle stick W is provided with a detachable knob X to which is securely fastened a narrow leather strap or cord Y. When the knob X is detached, the stick W is passed through perforations in the base board A and the spiral springs Z. The knob X is then fastened on to the end of the stick W as shown and the leather strap Y is coiled once around the wooden pulley G, then the free end of the cord Y is securely but temporarily fastened to the handle end of the stick W as shown. The fiddle stick is free to be reciprocated to the right and left by which means the pulley G and its connections are oscillated. Each of the spiral springs Z is fastened to the base board A and they serve as buffers against

FIG. 21

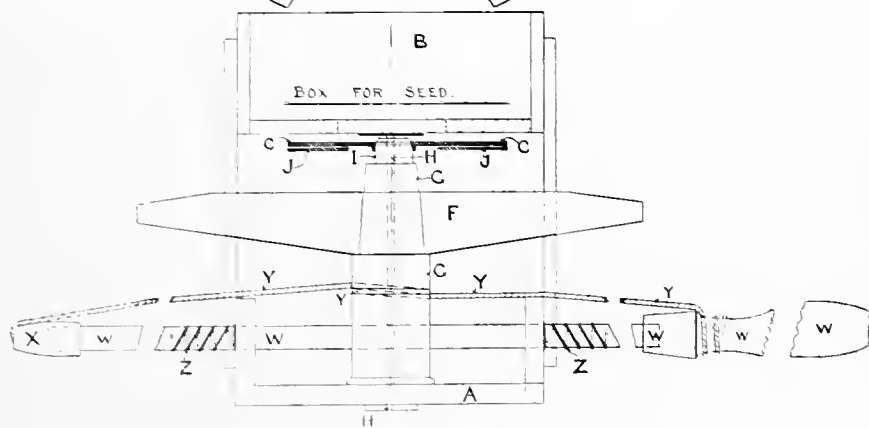
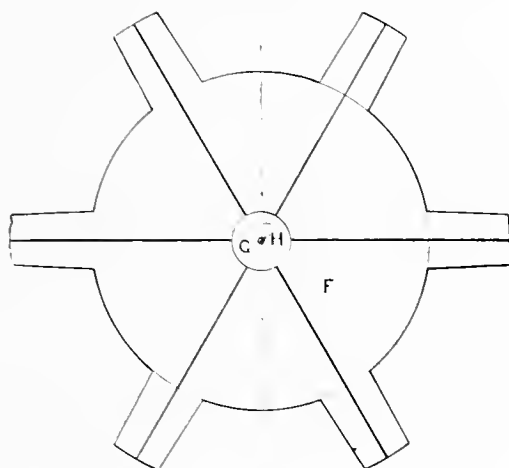


FIG. 20

the shoulder of the knob X, alternately with the shoulder of the handle part of the stick.

49. *Operation of the Mechanism.*—The sower fills his seed box B with sufficient seed to sow a double journey across the prepared field. For his convenience he employs two long poles, one at each end of the field and with a space between them equal to the average distance which the seed is thrown out of the machine. To one pole at the furthest end of the field the sower walks outward and it acts as a guide in keeping his traverse straight. On the return journey the second pole acts as a similar goal. As an alternative method, especially in a large field, the sower may use three sticks A, B, C, and place them initially as shown in Fig. 22.

The sower, on starting out from point 1, has the two sticks A and B in the same straight line to direct his steps; the stick C is placed 18 ft.—the full adjusted throw of the fiddle—on his right, that being the central point to which he will direct his course on the return journey. Immediately the sower reaches the first stick A, he, or his attendant boy, will move it 18 ft. to the right—position 5—directly in line with the stick C.

On reaching the stick B it is moved 36 ft. to the right, to the point 9, a distance equivalent to twice the throw of the seed and which is the central point of approach on the second outward journey. Meanwhile the sower makes the first return journey towards the stick C, and when he reaches the position 5 the stick A is removed to the position 8.

50. *The Work of the Sower.*—The sower carries the fiddle and seed suspended from his shoulder by an adjustable strap. When ready to commence sowing he moves the plate J and the adjustable bracket T so as to cover as much of the aperture D as is necessary to regulate or limit the amount of seed which is to continuously fall from the feed box B through the apertures D of the vibrating feed plate C and on to the oscillating and distributing fan wheel F. Then as the sower strides out with the left foot he moves the fiddle stick inwards to the left,

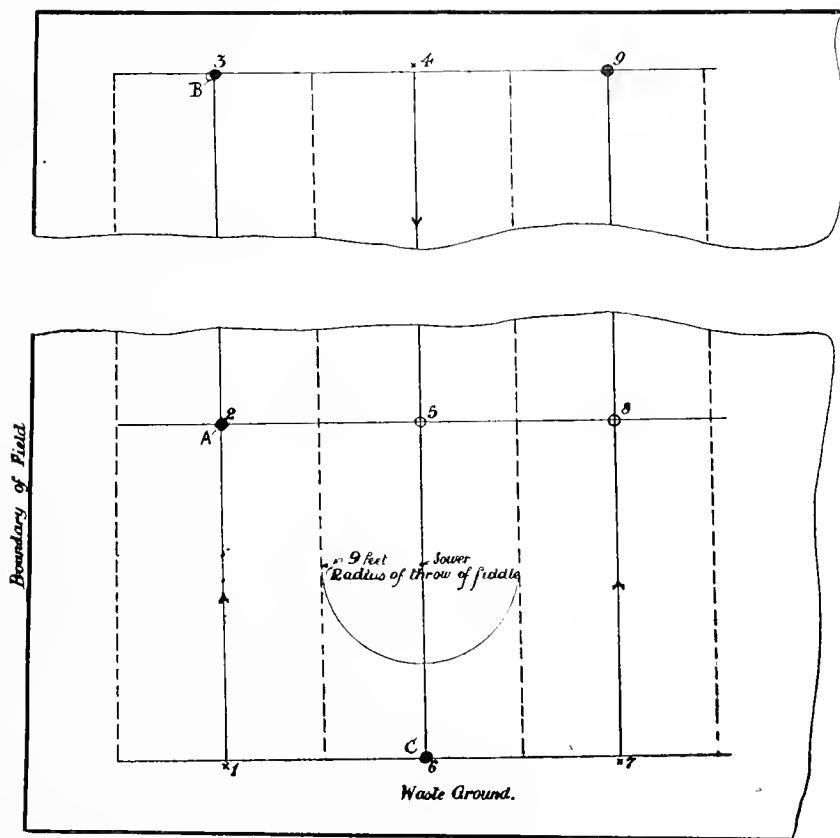


FIG. 22

and alternately outwards and to the right, Fig. 19, with each forward stride of the right foot. The constant reciprocation of the fiddle stick W oscillates the pulley G, spindle H, and eccentric brass pulley I. This pulley causes the plate C to slightly vibrate so that the seed, as it falls through the apertures in the base of the seed box is prevented by the constant vibration of the "fingers" of plate C from assuming any tendency to accumulate and jamb in the apertures of the feeding part. As the controlled seed drops through the apertures D in the plate C and on to the oscillating hexagonal fan shaped wheel F, it is scattered broadcast to the right, left, and in front of the sower.

CHAPTER VII

WEEDS AND WEEDING

51.—Weeds. 52.—Charlock. 53.—Redshank. 54.—Corn Marigold. 55.—Thistles. 56.—Field Bindweed. 57.—Flax Dodder. 58.—Dock. 59.—“ Clean ” Land. 60.—Detrimental Effects of Weeds. 61.—Weeding or Cleaning. 62.—Weed Prevention. 63.—Flax Pests and Diseases.

51. Weeds.—“ A weed is a plant out of place.” In no case is this quotation more true than when the weeds are in the flax crop. One of the many difficulties with which farmers have to contend is this natural vegetation which grows unsown and unaided by man.

The harmfulness of weeds to growing crops is self-evident to every observant husbandman ; they shoot forth in all bare patches of soil and so retard the freedom of growth of the cultivated plant. They further extract much plant food and absorb much moisture from the soil and in a corresponding degree starve the crop, especially when these properties are scarce. They serve as hosts for many pests such as insects and fungi, and incidentally, neutralize much of the work that is spent on thinning some farm crops.

The prime object of the grower of flax is to reproduce his selected type of seed and fibre and wherever possible to develop and improve the growing flax plants. The removal of all weeds may be included with drainage, tillage, and manuring as a contributory factor to the foregoing desired object.

The weeds most injurious to the growth and subsequent preparation of flax and also to the purity of any seed derived therefrom for future sowings are—

1. Charlock (*Sinapis arvensis*).
2. Redshank (*Polygonum persicaria*).
3. Corn Marigold (*Chrysanthemum segetum*).
4. Thistles (*Cnicus sp.*).



FIG. 23

FLAX WEED—CHARLOCK

5. Field Bindweed (*Convolvulus arvensis*).

6. Flax Dodder.

7. Docks (*Rumex*).

52. *Charlock* is a ubiquitous yellow-flowered weed and most troublesome pest ; strong and rapid in growth, producing an abundance of seed which usually ripens before the cultivated crop, and are then shed, thus increasing the difficulty of keeping the weed in check. The ripened seed possesses a wonderful vitality and will lie uninjured in the soil for years and germinate when turned up again to the surface, light, and air by the plough. Fig. 23 shows the complete plant about one-sixth its natural size at A, and at B the stem with seed pods, on a large scale.

53. *Redshank* is a serious pest. It is a coarse growing branched annual. The stems have red swollen joints and a dark patch appears in the centre of each leaf. Long clusters of small beadlike pink blossoms grow at intervals up the stem. Hand pulling will generally check and largely prevent seeding. (See Fig. 26.)

54. *Corn Marigold*.—On light or peaty soils the corn marigold becomes so abundant as to be a serious pest. It is an annual, possessed of great vitality. If pulled up and thrown aside it continues to ripen and shed its numerous seeds ; a mild season greatly prolongs its flowering period. (See Fig. 27.)

55. *Thistles* may be included among the worst of weeds ; they grow large and strong on good land and are especially troublesome at the time of the pulling of the flax and harvesting. They serve as a host for the mangold fly. (See Fig. 24.)

56. *Field Bindweed* is a small plant, attractive and beautiful ; it twines itself around the crop and retards its growth, doing much damage. When eradicated, which is a difficult process, it should be destroyed by burning. (Fig. 28.)

57. *Flax Dodder* is a most serious parasitic weed, which, under favourable conditions, attaches itself by means of



FIG. 24

FLAX WEED—THISTLE

suckers to its host and coils spirally around the stem of the plant, and unless checked by being plucked up with its host and burnt, it rapidly extends to neighbouring plants. In a short time large patches of plants may readily be strangled and exhausted. Careful cleaning of the subsequent flax seed will help to check its recurrence.

58. *Dock* is the bane of a flax cultivator. It is a stout and erect large-leaved plant, capable of attaining a height of 2 or 3 ft. ; it has a strong, tapering root which penetrates deeply into the soil. The dock serves as a host for the bean *aphis*, an injurious insect ; it also fosters a fungus growth. Like the thistle weed it may be pulled up by hand or cut by a knife when large in a crop of growing flax. Fig. 25 illustrates the upper and flowering part of this plant.

The dock, thistle, charlock, and bindweed are amongst the worst weeds found in flax.

59. "*Clean* " *Land*.—The land on which a crop of flax is grown should be "clean." Pests of the worst type are seldom dangerous in fields which are kept clean.

The weeds should be carefully, persistently, and systematically destroyed throughout the *rotation* series. According to personal observation and experience this is the most satisfactory method of dealing with undesirable



FIG. 25

FLAX WEED

Flowering part of the Dock

growths. Diligent and systematic destruction of weeds always repays the cost of same by the extra yield in the cultivated crop.

If, during the early stages of the growing crops, the weeds are permitted to grow to undue proportions, or, as in the case of the charlock, to reach the seeding stage, they are difficult to eradicate and eventually tend to almost choke and destroy the crop.

When flax is grown in a field singularly free from weeds, there is not only a relative increase in food and air for the growing flax stems, but subsequently, when pulled, stooked, and dried or retted and dried, the flax straw dries much more rapidly on account of the absence of weeds and grasses which can naturally absorb and retain more moisture than the flax plants themselves. It has been frequently observed that flax beets which contained a considerable portion of weeds or grasses were invariably more saturated after a shower, and retained the moisture for a much longer period than did the beets of flax which were clean and free from weeds. Further, if the season is unduly wet, the resultant fibre in the mixed beets is deteriorated in quality.

60. *Detrimental Effects of Weeds.*—When the weeds are allowed to mature and their seed to ripen much of it falls to the ground and thus automatically provision is made for a new crop of weeds in the same field during the following or some future season. A peculiarity of weeds is that they produce seeds capable of lying dormant in the soil for several years until turned up to light and air by the plough when they germinate.

The proliferation of seed by weeds is prodigious. One single plant of Charlock will produce 4,000, field bindweed 600, and corn marigold 13,500 seeds.

Many weeds are carried forward with the flax plants reserved for deseeding purposes, the result being that various seeds get mixed with the flax in the deseeding operation. Obviously these seeds must be removed in the later work of crushing

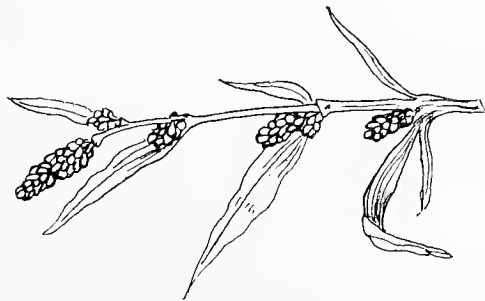


Fig. 26
REDSHANK

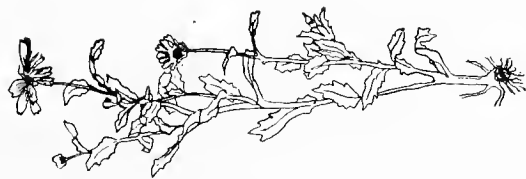


Fig. 27
CORN MARIGOLD

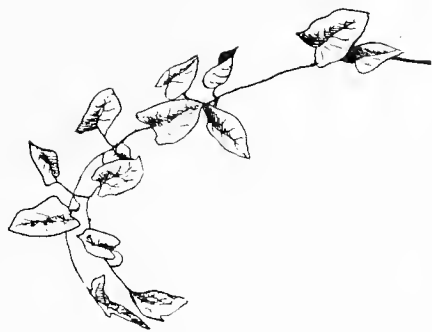


Fig. 28
FLAX WEEDS—BINDWEED

the seed capsules, screening and cleaning, in order to secure a greater purity of the flax seed retained for sowing.

Prof. Pammel, writing of the United States, says that farmers everywhere could increase their crops by about one-third by retarding the growth of weeds, and that the loss incurred by farmers would pay the taxes.

61. *Weeding or Cleaning*.—A great reduction of the growth of weeds in a flax field may be effectively accomplished by a careful and thorough harrowing and pulverizing of the soil to a fine tilth. Such operations tend to prevent the weeds from getting any opportunity to strike their roots into the soil before the time of sowing arrives, in which case they fail to germinate in advance of the young flax plants.

When the flax brairds are 2, 3 or 4 in. high, boys and girls should be sent to weed the flax field, barefooted, so as not to unduly damage or break the young plants. An arrangement was made for eight boys to weed, under supervision, a field of six acres of flax. Each boy was allotted an equivalent portion of the field and was provided with an apron of coarse canvas, the loose ends of which were attached to a narrow band suspended from the neck so as to form a convenient bag-like arrangement for the storage of the weeds pulled and collected on each journey over the field. The collected weeds were deposited in a heap and the weeder returned to his next contiguous part of the field and repeated the operation until the six acres were completed and cleaned of its weeds. The period occupied about a half day, and the work was sufficiently well done to require no further weeding of the field.

Very long and strong weeds are better cut off than pulled up by the root, at this time, for obvious reasons.

When the flax was ready for pulling the standing crop was singularly clean and free from weeds.

Many people advocate weeding against the wind so as to oppose the direction of the inclined brairds.

62. *Weed Prevention*.—It matters little which direction the weeders traverse so long as they exercise care. In a very

short space of time all the young plants will lift themselves up again. It is also worthy of note that when the soil is thoroughly pulverized during the preparation of the land by the spring and fine harrows and a raft of boards with pieces of wood arranged crosswise on the underside of the raft, the tendency of any weeds to take root is reduced to a minimum.

The *rotation* of crops greatly assists in retarding the growth of weeds because the different kind of treatment required for each variety of crop strikes at each kind of weed in its turn.

Liming is of considerable value in subduing the corn marigold.

Manuring generally is a valuable aid in the war against weeds for it enables the crop to keep pace and even outrun the growth of the weeds. Mineral manures, being free from weed seed and unlike farm-yard manure, tend to reduce weeds to a minimum. Nitrogenous manures favour their growth. In undunged and untilled land the weeds are most prolific.

The charlock is sometimes so rank in a field of growing flax as to discourage weeding by hand. In such circumstances the weeds may be effectively destroyed by *spraying* the field of young plants when about 5 or 6 in. in height with a 2, 3 to 4 per cent. solution of sulphate of copper—about 12 lbs. of copper sulphate to 40 gallons of water per acre being a good average. The solution should not be stronger than 4 per cent. as it would then be liable to permanently damage the crop in which the weeds were growing. It should be distributed by a machine which generates a fine spray under compressed air. The copper sulphate should be 98 per cent. purity and the water soft; wooden tubs or barrels should be used for the mixture.

63. *Flax Pests and Diseases*.—Weeds harbour both animal and plant pests which spread into and harm the crops. The flax plant pest is a species of fungus—micro-organism—commonly called rust. Recently the farmers in Ireland experienced a considerable loss with their early sown flax

owing to the ravages of the flea beetle and also of an unrecognised insect. One of the chief diseases which attacks the flax plant during its growth is a fungus which causes *yellowing*, and is known by that name. Other diseases denominated *flax wilt* and *flax rust* are due to species of micro-organisms which are probably the retting bacteria normally located in the flax stem but prematurely active.

CHAPTER VIII

HARVESTING FLAX

64.—Harvesting — Possibilities. 65.—Flax Culture a National Industry—Ireland and Belgium. 66.—Flax Pulling. 67.—Hand Pulling. 68.—Flax-pulling Machines. 69.—Machine Types—Rotary Drum and Radially Oscillating Combs. 70.—Puller Belts and “Butting” Mechanism.

64. Harvesting—Possibilities.—There are numerous possible methods of harvesting a flax crop, dependent primarily upon the object for which the crop is cultivated. In some respects the cultivation of flax may be classed as a double crop; *first*, the stalk contains a valuable textile fibre, and *second* the fruit or seed of the plant is useful either for subsequent sowings and the propagation of its species or for feeding cattle.

When the flax crop is approaching the period of harvest two important courses of realizing it are available to the owner—

- (a) To harvest the flax for its fibre only.
- (b) To gather in the crop for both fibre and seed.

With the adoption of the former policy the operations are few and include pulling, retting, spreading (drying) and scutching. Many flax growers and farmers are induced to decide on this policy, because in a relatively short period of time the series of operations are completed and the flax product is converted into cash. The adoption of this policy involves the loss to the farmer and the community of the crop of valuable seed, either for feeding or sowing as well as the remunerative labour.

With the adoption of the latter policy the operations required are more numerous, elastic, varied and remunerative than are those of the former method. It also offers several alternatives, *e.g.*—

1. Pulling, deseeding the green or semi-ripe seed bolls and

artificially drying them for feeding purposes. The deseeded straw is immediately retted, dried, and scutched.

2. Pulling the flax and arranging the beets in long stooks, or gaiting, to dry in the field ; deseeding, cleaning, and drying the bolls after which they are stored until required for sowing. The flax straw may then be retted, dried, and scutched without further delay, or as an alternative, the deseeded flax straw may be stacked until the following spring and then dew or pond retted, dried and scutched.

3. The pulled flax may be dried in stooks, stacked and deseeded at will during the winter months and dew retted or steeped in the spring as convenient.

4. A portion of the flax crop may be treated as in the case of No. 2, and the remainder as No. 3.

65. *Flax Culture a National Industry—Ireland and Belgium.*—The various foregoing choices of harvesting make flax a very desirable farm crop. The farmer can have as much remunerative work as he chooses and according to the labour which he has available. Any remunerative scheme which tends to increase the number of workers in the country districts is a national advantage. The industrial classes with means are always relatively the best cash spenders in any market. A relatively extensive peasantry provided with sufficient and remunerative employment always tends to generate an industrious and contented people who are indirectly the main spring and most stable pillars of prosperity in any country.

Agriculture is still the chief national industry in the British Isles, particularly in Ireland, and when combined with commerce constitutes an important national asset.

The cultivation of flax is an advantageous crop in the rotation series of farm crops. In Ireland it has frequently been denominated the "Rent-paying crop," and in Belgium the "Golden crop."

The Belgians, in the earliest decades of the nineteenth century, were in great poverty but by the aid of British gold and the encouragement given by England to the cultivation



FIG. 29

FLAX PULING AND STOOKING

of flax in Belgium, they so improved their condition that in a short time there were scarcely any poor in the villages which soon developed into large and industrious towns.

66. Flax Pulling.—From time immemorial it has been the practice to pull flax up by the roots rather than cut it as in the case of corn, etc. ; three reasons among others are assigned for this preference—

1. Flax tends to become sour and deteriorate about the point of severance.

2. Cutting shortens the length of the straw and the commercial length of scutched fibre and thus a considerable amount of waste is involved.

3. The weeds in the field would be cut with the flax when harvested, and these are troublesome in every subsequent operation of preparing the fibre which would thereby be materially reduced in value.

The correct time to pull flax requires *a considerable nicety of judgment*.

The most critical period, in flax growing, is immediately after sowing and until the brairds have sufficiently covered the soil to keep the sun's rays from parching the young plants.

In Ireland the plants begin to bloom about the end of June, when the mass of blue flowers present a beautiful appearance ; during this period the stalks shoot up rapidly, about one inch being added to their length each day. When the flowers begin to fall the plant ceases to grow in length ; the seed bolls begin to appear and continue to develop until about the middle of July (for the earliest crops). At this period the seed bolls are globe-like in appearance and should each contain ten pickles of seed. At first the seed is milky and whitish, but gradually it solidifies and from a milky white colour it passes through the pale green to a brownish tint. When the flax seed has begun to change to a pale-green shade it is advisable to examine the bolls every day. Select the ripest capsules, cut them transversely, note carefully the changes and decide to pull according to one of the following indications.

(a) If the flax is pulled while the stems are just emerging from their green state, the fibres will still retain their natural strength and glossy and silky characteristics.

(b) Many experienced growers commence to pull the flax immediately after the fruit flowers have fallen, the stems begun to turn yellow and the plant leaves to fall.

At this stage the seed in the capsules will have begun to change from their milky-white substance to a greenish colour and be moderately firm to the touch.

(c) Some cultivators do not begin to pull the flax until the stem leaves have fallen to about one-third their length from the soil, the seed in the capsules changed from green to a brownish tint, and the seeds themselves are quite firm and free from moisture. When flax is pulled at this stage and left to winnow for about a week in the field the seed capsules may be rippled off in their green or semi-ripe state, cleaned and dried in the wind and sun, and stored to be eventually crushed and cleaned for sowing purposes. In Belgium and Holland this practice is common; it has also been successfully accomplished in Ireland.

It requires courage as well as judgment to pull flax on the *green* side. Where the fibre is the only desideratum, an experienced and successful flax grower estimates that for every farmer who pulls his flax at this stage, 500 pull theirs when it is over ripe.

67. *Hand Pulling*.—The operation of manual pulling of flax is simple and easy to learn. (See Fig. 29.) The experienced puller usually lays hold of as many standing flax stems with his left hand as the reach of his fingers will permit. Simultaneously with his right hand he gathers as many of the adjacent flax stems, and continually adds them to those in the left until he has a sufficient number of stalks to make a reasonably good-sized handful; these he then grips with both hands, and together with a peculiar twitch of the knee and movement of the arms, he pulls the complete handful of stalks up by the roots, as free as possible from soil and weeds.

About six handfuls of pulled flax are carefully arranged together to form a *round* beet or sheaf, or the handfuls may be alternately laid crosswise in the beet so as to facilitate

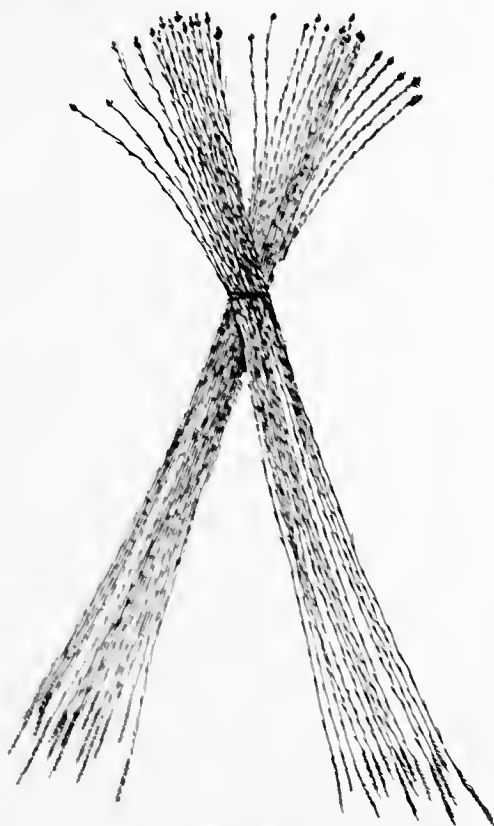


FIG. 30

CROSSED HANDFULS OF PULLED FLAX TO FACILITATE DRYING

drying in the stooks and subsequently rippling. This arrangement is illustrated at Fig. 30 and should preferably be adopted whenever it is proposed to dry the straw and save the seed.

The root ends of the pulled flax should be kept "square" and the beets made to a uniform size. (See Fig. 36.)

When the growing flax stems are of different lengths due to any cause of indifferent preparation or variety of soils, or mixture of two or more classes of seed, a careful cultivator and preparer of flax will first pull the longer stalks by catching them just underneath the seed bolls. The shorter lengths of flax are then taken at the second handful or, alternately, by followers.

Different lengths of flax should, as far as possible, be kept separate. If they are pulled and retted together, the shorter lengths fall out of the bundles into the tow and waste during the scutching operation. Adherence to the foregoing details requires time and care, but they are well worth attention. Flax pulled in wet weather does not dry evenly. The beets should weigh from 7 to 10 lbs. each. Eight flax pullers of average ability will pull a statute acre of flax per day; an exceptionally good man, 15 stooks per day of ten hours. A stook contains 12 beets of 24 in. to 27 in. circumference. 80 to 90 stooks should be harvested from each statute acre, or an equivalent of 40 to 50 stooks for each bushel of seed sown.

68. *Flax-Pulling Machines*.—The incomparable utility of flax for aeroplane fabrics, apart from the increasing appreciation of linen for household purposes, decoration, and personal apparel and use, makes it increasingly evident that the growth, preparation, and supply of flax fibre for the linen industry must not only be maintained but materially increased in quantity of production.

Further, the raw material for the flax spinner and linen manufacturer and the seed for sowing or feeding must be offered in the markets at prices which compare favourably with the price of raw materials used in contemporary and competing trades.

The attainment of these objects involves the creation and introduction of new and improved mechanical or other means of harvesting the flax crops.

The usual method of pulling flax by hand is relatively slow and expensive. It is with the view of expediting the

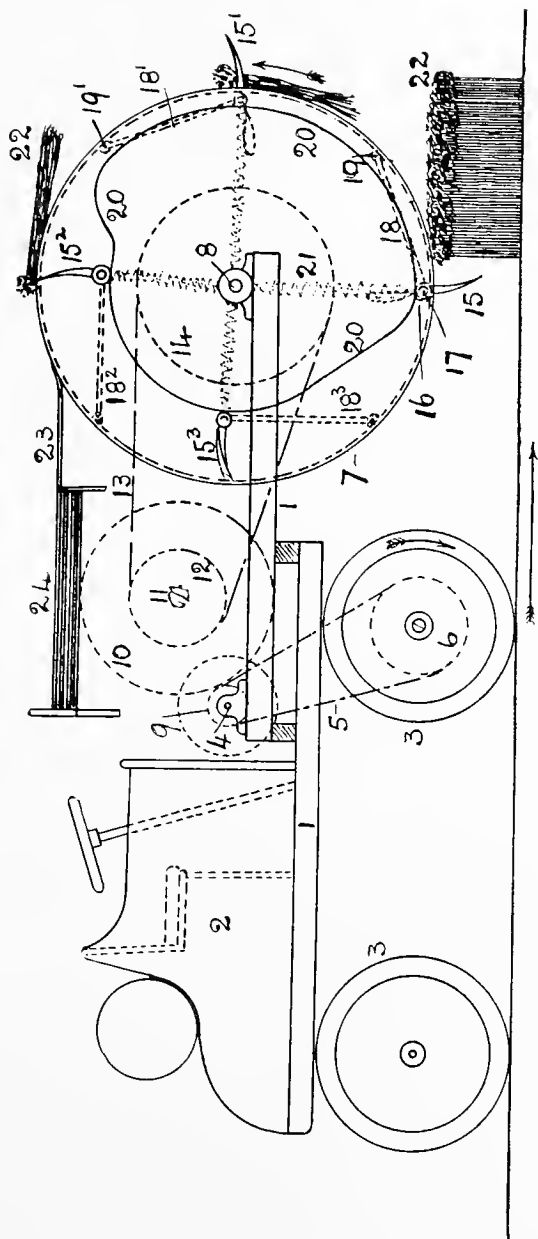


FIG. 31

harvesting operation and of reducing the relative cost that flax pulling machines have been invented.

It is neither possible nor advisable in this treatise to attempt to describe all the details of the different flax-pulling machines that have been invented and introduced to the public.

The fundamental principles of some of the flax-pulling machines have, however, now been established. The details of mechanism are the chief factors which await solution. Gradually these minor difficulties are being eliminated.

The following examples have been selected primarily to illustrate two essentially and fundamentally different principles and types of machines designed to pull flax from the soil in which it grows.

69. *Machine Types* —*Rotary Drum and*

Radially Oscillating Combs.—Messrs. Jas. G. Crawford, Belfast, and Robt. M. Bennett, Carryduff, Co. Down, Ireland, have designed and used a flax-pulling machine of this type to replace hand labour. Briefly it consists of a large drum or cylinder, 4–6 ft. in diameter, mounted and free to rotate in suitable bearings placed in front of a motor-propelled vehicle. A number of combs, each the full width of the cylinder, project at equal intervals and at suitable angles from the periphery of the cylinder. The combs are actuated by negative or positive cams or other eccentric mechanism, so as to engage the “beets” of the flax immediately below the bolls and lift the flax plants out of the ground.

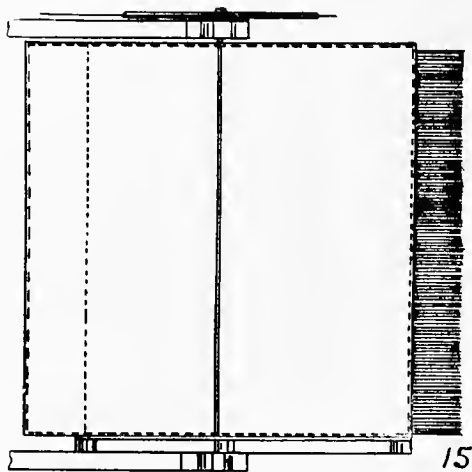


FIG. 32

The chief details of this mechanism are illustrated at Figs. 31 and 32, of which the former is a sectional elevation of the machine and the latter a plan view of the pulling drum. The numerals in each diagram refer to corresponding parts. 1 represents the framework or chassis and extension of the small motor vehicle, 2 a seat for the operator, and 3 the wheels on which the car is supported and free to travel. It may be propelled by horse traction or automatically by a self-contained motor. When the mode of propulsion is automatic, a driving pulley on the motor shaft 4, not shown, but mounted on the chassis 1, communicates rotary motion through a belt 5 to a pulley 6 compounded with the axle of the carriage wheel 3.

The extension of the chassis 1 carries the overhanging drum 7, supported and free to rotate about the bearings 8. Rotary motion is imparted to the drum 7 through the medium of a spur-pinion 9, on the motor shaft 4, gearing into and driving a spur-wheel 10 on the supplementary shaft 11. A pulley 12 on the same shaft drives through the belt 13, a pulley 14 compounded with the drum 7.

The periphery of the drum 7 is provided with four apertures at equal distances apart. A comb 15, provided with an anti-friction bowl 16, is mounted on the stud 17 in the free end of a lever arm 18, in turn pivoted internally to the stud 19 in drum 7. The comb 15 and its duplicates are free to radially oscillate, externally or internally, through their respective aperture of the drum. The anti-friction bowl 16 is kept in rolling contact against the varying surface of a negative and stationary cam 20, independently mounted at the end of and concentrically with the drum 7. A spiral spring 21 is attached at one end to the stud 17 and at the opposite end to a fixed position coincident with the drum centre or bearing 8. The function of the spring is to maintain a constant contact between the anti-friction bowl 16 and the face of the cam.

The action of the foregoing mechanism and the operation of pulling are as follows: As the machine moves forward

its wheels, 3, rotate clockwise; simultaneously the drum 7 is pushed into the standing flax and rotates counter clockwise, through the combined action of the parts 9 to 14 inclusive, and the comb 15 is gradually pushed radially through the aperture of the periphery of the drum 7 as a result of the continued negative action of the non-rotating cam 20. With the continued rotation and forward motion of the drum 7 the comb 15 penetrates between the flax stalks 22 below the bolls, rises and engages with the bolls with sufficient energy to pull the flax plants out of the ground (see position of comb 15¹) and carry the flax to the top of the drum 7, where it is gradually pushed over a lattice 23 to a conveyer or canvas belt 24, which delivers the pulled flax on to an automatic binder of standard type. As the cylinder rotates, the succeeding combs repeat these operations. The cylinder, with the radiating combs, is adjustable to suit the height of the standing crop.

70. *Puller Belts and "Butting" Mechanism.*—This type of machine, designed by B. S. Summers, Port Huron, Michigan, U.S.A., serves the three-fold purpose of pulling the flax, evenly "butting" the root ends and automatically binding the plants into bundles or "beets." Briefly the mechanism consists of a carriage, free to be drawn over the harvest field by draught animals or otherwise. Mounted on the carriage is a series of endless sprocket-chain belts or "puller" belts, supported and free to rotate on sprocket-chain wheels, in turn mounted on a strong frame which inclines from front to rear of the machine. These belts have associated with them types of water-proofed leather or other compressible and flexible substance between which the flax plants are grasped, pulled, elevated, and fed substantially in their normal vertical position rearwardly to the binder machine.

The main features of the mechanism are illustrated at Figs. 33, 34, and 35. Fig. 33 is a part plan of the puller mechanism on a plane parallel to the plane of the puller belts. Fig. 34 is a transverse section in elevation and Fig. 35 is a

front elevation of the pulling part of the machine. The numerals in each diagram refer to corresponding parts.

An axle shaft 1 supports the frame gables 2 and carries a series of rollers 3, suitably spaced, and on which the machine

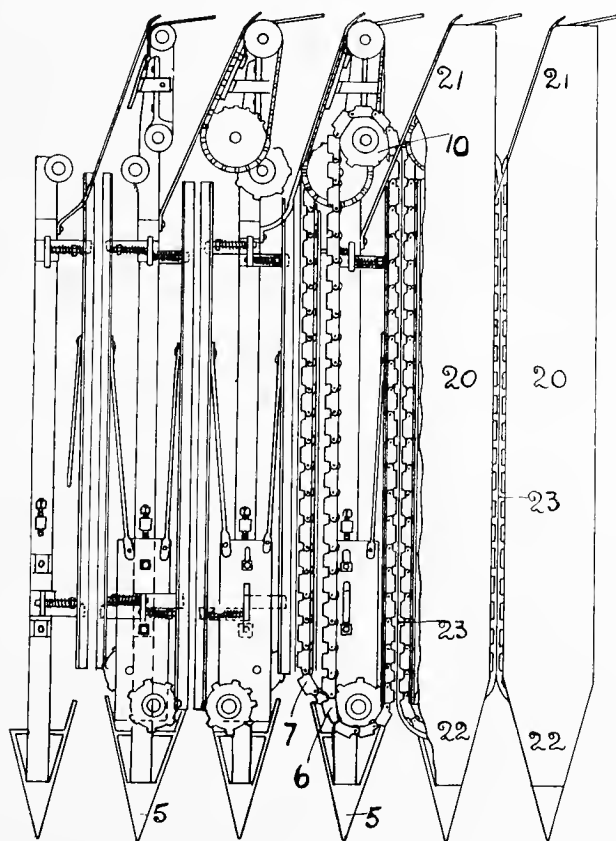


FIG. 33

travels; 4 shows one of a series of transverse bars inclined from the front to the rear of the machine. The heads of the bars are curved and arrow-shaped, as shown in the illustration at 5. Mounted upon each supporting and inclined bar 4, are two puller belts 6 and 7, denominated the lower and upper

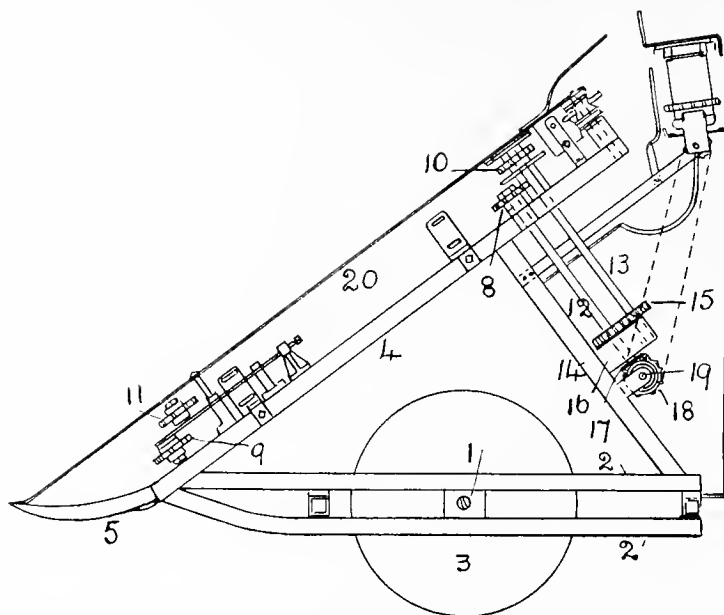


FIG. 34

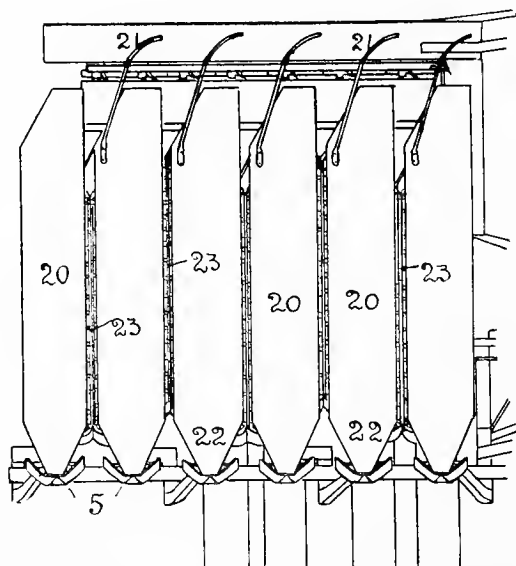


FIG. 35

belts respectively. The lower belt is carried by a driving sprocket 8 and a carrier or supporting-like sprocket wheel 9. The upper belt 7 is carried by a driving sprocket wheel 10 and a carrier or supporting sprocket wheel 11. The driving sprocket 8 is compounded with the shaft 12 and the driving sprocket 10 with the shaft 13. The shafts 12 and 13 carry like spur wheels 14 and 15 near their base, the teeth of which intermesh and rotate with like uniformity. Both shafts are supported in the bracket 16. Rotary motion is primarily communicated to the shaft 12 through the medium of a bevel wheel 17, compounded with and near the base of shaft 12, the teeth of which wheel intermesh with those of the like bevel wheel 18 fast to the main driving or motor shaft 19, and which supplies the initial motion to the pulling mechanism.

The puller belts 6 and 7 are slightly apart in the vertical plane, but they partially overlap each other. The upper belt 7 co-operates with a similar belt upon an adjoining and contiguous duplicate bar 4. The lower belt 6 co-operates with a like belt on the supporting and duplicate bar 4 on the opposite side. The design of this arrangement facilitates the use of a relatively larger number of puller belts, than would otherwise be the case, were all the belts arranged in the same plane.

Each puller belt is of the sprocket chain type, and compounded with a gripping rubber device or other compressible material, between which the growing plants can be gripped. A cover plate 20 is introduced between the puller belts, to assist in keeping them free from clogging with weeds or other foreign matter. The front part of the plates 20 is tapered as at 22 to serve as guideways, assisted by spring guides 21, for the groups of flax plants to the "bites" of the puller belts. They are spaced between contiguous plates, as at 23, sufficiently to allow a free passage for the plants. At the upper and rear ends the cover plates are reduced so as to facilitate the feeding of the plants to the transfer chains and the automatic binder.

The operation of the mechanism and pulling is as follows : As the machine is moved forward towards the standing flax the arrow heads 5 of the supporting bars 4, together with the tapered ends 22 of the cover plates 20, enter into and separate the flax plants into approximately equivalent groups and so guide them to the nip of the respective pairs of puller belts where they are continuously gripped, raised, and carried rearwards from the soil by the combined action of the continuous forward movement of the machine and the equivalent rearward surface traverse of the puller belts. The flax plants are gripped by the contiguous pairs of belts in their approximately upright positions, but at slightly different distances from the roots ; they are evenly “ butted ” as they are pulled from the soil and conveyed rearwards in these conditions by the belts to transfer chains and from these to the “ bite ” of the binder mechanism.

CHAPTER IX

SAVING THE FLAX SEED

71.—Fibre and Seed. 72.—Farming Experiments. 73.—Theory of Imported Seed. 74.—Experimental Results. 75.—Harvesting Practices. 76.—Final Stacking—"Windrows" 77.—Deseeding. 78.—Artificial Heat.

71. Fibre and Seed.—It has been generally experienced that when flax straw is pulled and retted in the green state, the resultant fibre is finer and silkier than the straw pulled at a later and more matured stage, but the total yield in volume and weight of fibre is relatively smaller.

The desire and demand for fine and silky fibres are some of the chief factors which induce some flax growers to sacrifice the seed and ostensibly cultivate only for fibre. It consequently happens that when the plants are pulled at such an *early* period, the seed in the bolls is immature and too small in size, and too light in weight for sowing. This seed may, however, be ripped off the green stalks, artificially dried and then crushed for feeding purposes.

When it is proposed to save both the fibre and the seed, it is usually better and safer to delay the pulling operation from two to three days longer than would be considered necessary if pulled for fibre only. Then if the straw, with the seed capsules, is left to winnow and dry in the field, experience has often proved that, though the flax seeds are not quite matured at the time of pulling, the sap in the stalk will continue to further nourish, perfect and mature the seed sufficiently as to make it suitable to be saved and garnered for subsequent sowing.

In every case when the flax crop is carefully handled and harvested, the net result of the *double* crop is always much higher than for the *single* crop of fibre or seed only.

The yield of clean seed should vary from three and a half to

four bags per acre cultivated, or seven to nine bags of clean sowing seed for every bag sown. The yield of scutched flax fibre should vary from 32 to 40 stones per cultivated acre. In 1917 a County Down (Ireland) farmer reaped nine bags of excellent sowing seed from one bag of seed sown. In the same year and county a farmer divided his crop into two sections, one of which he harvested for fibre only, the other he pulled, stooked, dried, stacked, deseeded, and retted in the spring of 1918. The total receipts for the latter were exactly twice those of the former.

It is interesting to note that many flax growers who stack their flax and defer the retting until the following summer, assert that the resultant fibre is approximately 10 per cent. better in yield and quality. With this view the Dutch experience concurs. There are, however, flax growers who are diametrically opposed to this view.

72. *Farming Experiments.*—Some years ago an Irish farmer pulled about 100 beets of green flax and retted the same immediately. A fortnight later the main crop was pulled, dried, stacked, deseeded, and retted in the following year. The quality of the fibre of the former in respect to fineness was superior but good fibre was only found in the middle of the stem, and the yield was 30 per cent. less than that of the main crop.

Another Irish farmer cultivated 24 statute acres of flax and produced 345 bushels of excellent seed—an average of 14 to 15 bushels per acre. The scutched flax yielded over 30 stones per acre, and the price received for same exceeded by 20 per cent. the average price for the given year—a sufficient evidence that the flax does not necessarily suffer in relative value because of the deseeding operation. In the following year 56 acres were sown with this Irish-saved seed, and 8 acres with Riga and Dutch seed. The home-saved seed germinated and brairded sooner and produced a better crop than did the imported seed. During the present year many farmers have obtained flax crops from Irish seed, well saved,

which are superior to any crops grown from imported seed including Dutch.

73. *Theory of Imported Seed.*—The theory has been industriously propagated and readily believed that imported seed is much superior to home-saved seed, but the idea is erroneous. British seed, carefully saved and thoroughly cleaned, is as good for sowing as any seed that can be imported. The cleaning is simplified if the grower keeps down the weeds during the cultivation of the flax crop. The soil of the British Isles is equally fertile, and the climate as genial as that of any Continental country celebrated for the saving of flax seed. The only thing wanted is an incentive to justify the effort, combined with the best knowledge of managing crops.

So long as the foregoing theory is circulated, wholly or partially, for which no satisfactory reason is ever assigned, so long will a complete supply of sowing seed have to be imported each year.

The foregoing examples demonstrate that it is possible to produce a valuable crop of flax united with the advantages of well-matured seed.

Some growers have contended that when the flax is allowed to remain in the soil until the seed is more thoroughly matured, the quality of the flax is inferior and the soil more exhausted, as a consequence. If there is any truth in the latter contention, the argument supports the double crop policy, since the object of every crop is to convert the soil into a more suitable and valuable commodity—the production of seed is the crowning work of the plant's activity. Experience and results have often proved that the flax can be grown and the seed ripened without detriment to the flax; in any case the product of the seed is more than equal to any difference in value of flax fibre and extra labour involved.

74. *Experimental Results.*—Summarizing the results of many experiments and observations, it may be stated, the return in value for the fibre is approximately the same for methods 1 or 2 (pages 63 and 64 respectively), and relatively better for

methods 3 and 4 (page 64). If the saving of the seed is taken into account, the three last methods are more remunerative in cash return per acre of land to the grower, apart from the extra amount of remunerative labour employed.

75. *Harvesting Practices*.—Assuming, then, that it is proposed to harvest the flax crop for fibre and seed, the pulled flax must be made into suitable beets, put up into stooks, and winnowed and dried in fields on one or other of the following methods—

A. The flax should be pulled in small handfuls—about the size of an average man's wrist ; these should be laid diagonally and alternately across each other as illustrated at B, Fig. 36. Beets, thus made with about six handfuls in each, are relatively small, being about half the usual size, but this materially assists the process of drying and facilitates the subsequent operation of rippling. Each beet must be tied with an easily detachable knot or bow and placed broadside to broadside. The beets are arranged in pairs with their root ends about 1 ft. apart and their heads and bolls leaning against each other and so tending to keep each other in an erect position. Repeated and duplicate pairs of beets are added until a long straight row or "stook" is formed. A normal stook contains twelve beets of average size. The length of the row is immaterial and is made to suit the convenience of the grower, but the direction of the rows should be north and south by preference, so that one side of the stook will receive the morning and the other the afternoon sun. The foregoing plan of constructing the beets and arranging the stooks is ideal, since the breezes can freely winnow through the natural openings in the stooks, without blowing them down, except in very stormy weather. Given fine weather and a moderate breeze it will then only be necessary to turn the beets of each row once, so that the inside portions may be alternate with those of the outer portions, and the whole stook completely winnowed and dried sufficiently to permit an immediate start at the rippling or



FIG. 36

FLAX BEET OF THE
USUAL ROUND TYPE

FLAX BEET OF
CROSSED HANDFULS

DESEDED,
ROUND FLAX BEET

deseeding. Fig. 37 shows a photograph of a flax field in which the beets are made of crossed handfuls and arranged in stooks as just described.

B. As a second and alternative method the handfuls of pulled flax may be placed, without being tied into beets, in an inclined position against a straight rod R, 9 to 12 ft. in length and 1 to 1½ in. in thickness. This rod may be supported in a horizontal position upon the tops of two stout upright stakes, driven into the ground and notched at the top so as to freely receive the horizontal rod which may be of wood or iron; when more convenient, strong ropes or wire are sometimes stretched between the upright posts. The handfuls of green flax should be separately shaken or opened out when being placed against the horizontal rod. The root ends of the flax of each side should be about two feet apart. These arrangements facilitate the free circulation of the air between the flax stems. This method, which is sometimes denominated the "*Long Gait*," is illustrated by a pen and ink sketch of the plants as they stand in the "*gait*," at Fig. 38.

The foregoing arrangement necessitates the use of a considerable number of stakes, rods, etc., but in favourable weather the straw can be completely dried without having to be turned and in unfavourable weather the gaits will resist well the wind and rain.

C. A third method is sometimes adopted by making large beets and standing them up in the form of cones as illustrated at Fig. 39. This method is denominated the "*Round or common gait*." (See also Fig. 73.) The handfuls of flax are spread out on the ground in an arc of a circle, with their heads turned towards the centre. The stalks are then lifted from the centre and formed around the worker's leg into the desired cone shape with their root ends projecting at the base as illustrated. The round gaits must be turned at least once, and if blown down, they must be immediately lifted into their standing position.

Given moderately fine weather, the capsules and seeds for

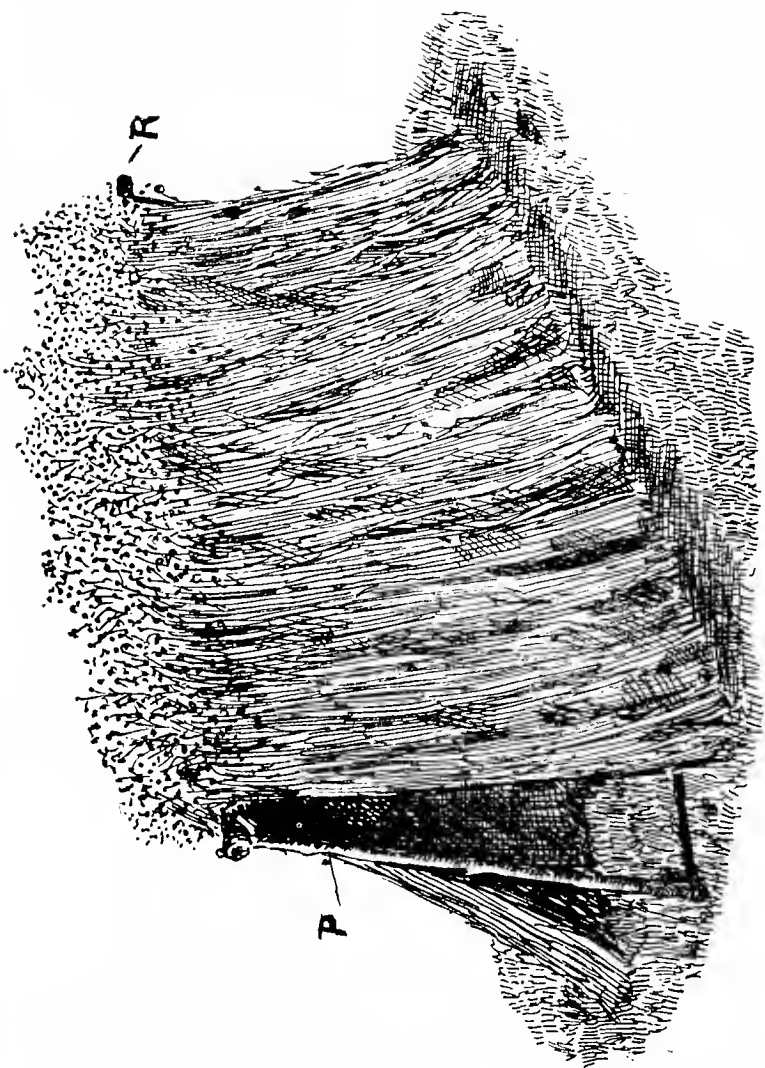


FIG. 38

DRYING UNDESEEDED FLAX—LONG GAIT

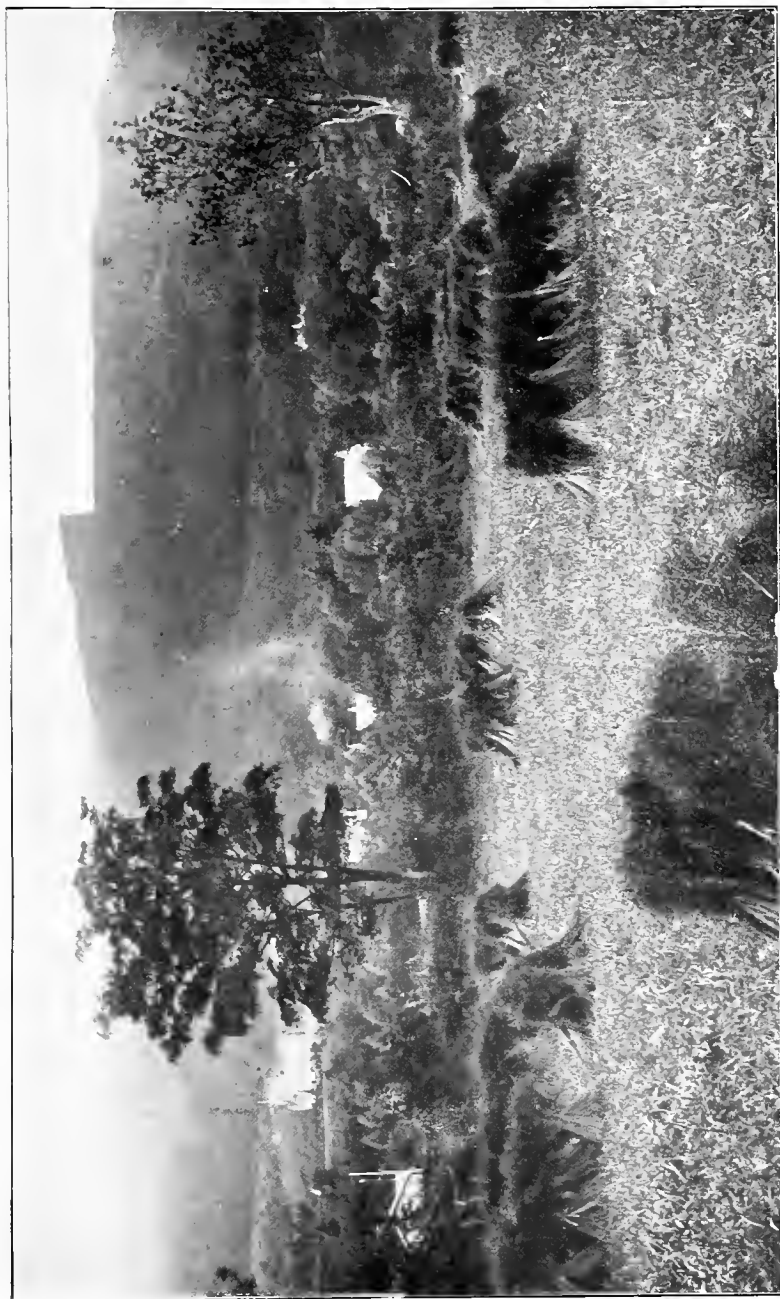


FIG. 37

FLAX IN STOOKS, DRYING BEFORE DESEEDING

each of the three given methods will be sufficiently matured and dried to permit of the rippling or deseeding of that portion of the flax which it is desired to ret, dry, and scutch immediately.

76. *Final Stacking*—"Windrows."—The remainder of the

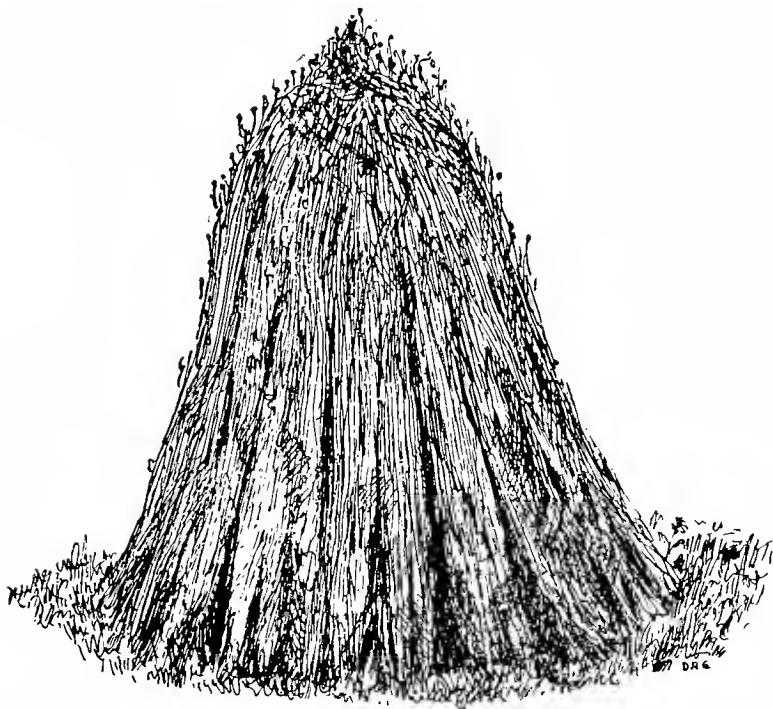


FIG. 39

DRYING UNDESEEDED FLAX—ROUND GAIT

flax, however, will not be sufficiently dry to build into a large stack. The final stacking must be approached very cautiously. A very good plan is to arrange the beets partially dried as above in "windrows," as illustrated at Fig. 40. This is a photograph of such a windrow in course of removal to a "Dutch" barn or more permanent stack. Any other similar

or alternative plan may be adopted to thoroughly dry the straw.

A windrow may be built up as follows: Form a gait of any convenient length by first adjusting two rows of beets with their root ends apart and their heads leaning against each other. Three additional rows of beets may be added to each side, making eight rows in all. Further additions may be added to the top and built in such a way as to form a slanting roof so as to facilitate, if necessary, rapid covering in very wet weather and induce the water to freely run off and clear of the lower rows of beets; as a precautionary measure the windrows may be temporarily thatched with the deseeded flax straw or other available material.

In the windrows, the beets are not closely packed together as in normal stacking, and the air and wind can freely circulate among them. The straw should, therefore, soon be thoroughly dry and ready for deseeding at once or building into a permanent stack.

77. *Deseeding*.—The deseeded flax straw may then be made up into round beets of normal size as at C (Fig. 36), retted, dried and scutched at once if desired. The capsules, or seed bolls, must then be freed from short and loose straws, leaves, dirt, and foreign matter.

If the weather is settled and dry the cleaned capsules may be evenly spread, about 3 in. deep, or in small drills, as illustrated at Fig. 41, on sheets arranged in any breezy part of the field, or, as an alternative, they may be removed to some central situation prepared with a concrete or other smooth floor surface which is exposed to wind and sun. The bolls should be turned over two or three times each day until thoroughly *air* dry, when the whole may be collected into loosely woven canvas sacks and stored in an airy loft until required for subsequent crushing, cleaning, and sowing. In showery weather the capsules should be collected into heaps and temporarily covered. Immediately the rain ceases the seed bolls must be spread out again. A few small showers will



FIG. 40

CARTING FLAX FROM THE "WINDROWS" TO THE BARN OR STACK

not do any harm but should the weather be very unsettled and wet, the rippled bolls may be spread out evenly on the floor of a loft, through which a constant breeze can freely blow. In any case the bolls must be repeatedly turned over until quite dry. Before putting the dried capsules into sacks for storage it is preferable and desirable to expose them for a few hours in the open air on any fine day.

78. *Artificial Heat.*—The application of artificial heat is very dangerous and liable to reduce the percentage of germination. If any such heat be used it should not exceed 70° F. Fig. 42 is a photograph showing 100 per cent germination of seed removed from the capsules five months after deseeding. This flax was deseeded ten days after pulling, and saved as described above.

An enterprising farmer will watch for every opportunity to forward the operations in which he is interested, and not wait for a long period of serene weather, which may never come at all, and as a consequence lose all his crop. Wherever the climate is very unsettled the farmer has to gather in his harvest in snatches or not at all. As Shakespeare says, though in slightly different phraseology, there are tides and times favourable to the harvest which, taken at the flood, lead on to fortune, but if neglected never occur again and total failure is the result.

CHAPTER X

DESEEDING METHODS

79.—Elimination of Flax Seed or Bolls. 80.—The Ripple. 81.—“Ripple” Machinery. 82.—“Rippling” Operation. 83.—Rotary Ripple. 84.—The Hand “Morston” 85.—Conveyer Belts and Oscillating Coml. 86.—Two or Three Rollers. 87.—Two single Pairs of Rollers. 88.—Multiple Pairs of Rollers. 89.—Greeve’s Reels. 90.—Separation of Flax Seed into Different Weights.

79. Elimination of Flax Seed or Bolls.—The flax seed, or seed bolls, may be removed from the flax straw in one of several ways. If the seed bolls are removed whole it is preferable to delay as long as possible, the operation of crushing the bolls and cleaning the seed. When this policy is adopted, the vitality and high percentage of seed germination is generally best retained.

The particular form of deseeding is influenced to a considerable extent by the condition of the flax straw at the proposed time, *e.g.*, whether green or partially or wholly dry.

80. The Ripple.—The operation of rippling the seed bolls by hand is performed by drawing the flax stems freely and quickly through the teeth of a coarse, upright, steel comb. The method is old, useful, and most satisfactory for removing the bolls from green or partially dried straw. The hand ripple is still preferred by many large and most small flax growers for deseeding the dry straw from the stack.

It is interesting to note that in the whole range of inventions of textile machinery, those machines which were eventually standardized were always of the type which most nearly accomplished the work in the way it had been hitherto performed by hand, and even for this reason alone each essential movement in hand rippling should be carefully observed.

In hand rippling the weeds, largely charlock and red shank,

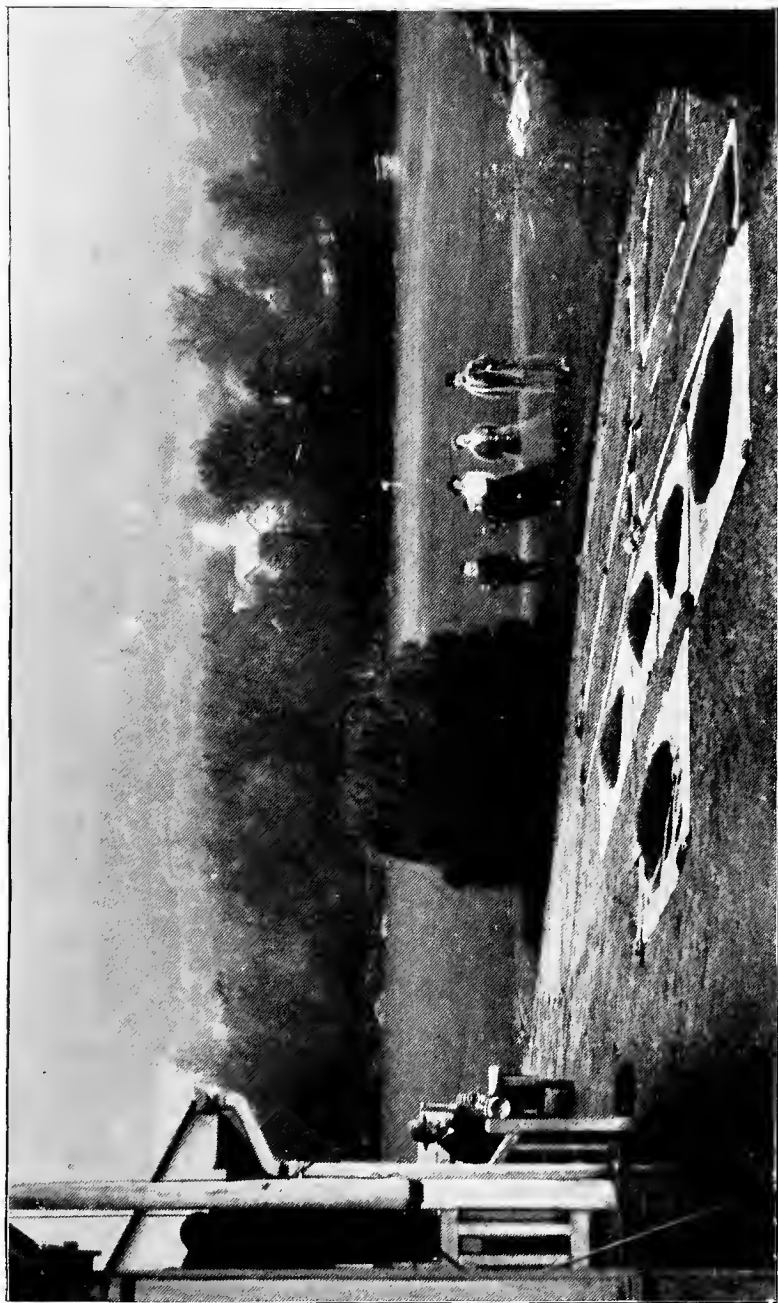
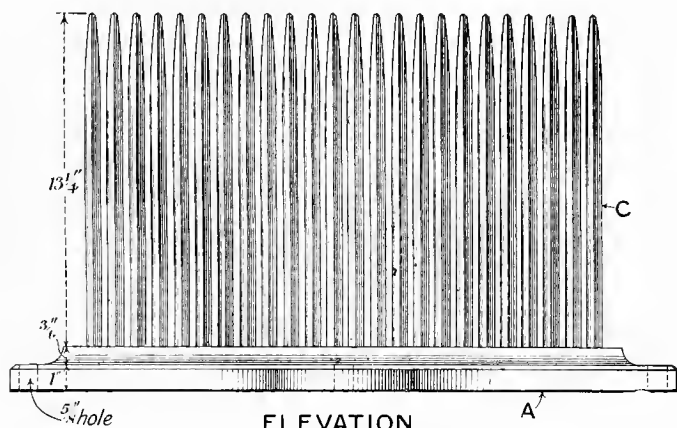


FIG. 41

DRYING FLAX SEED IN BOLLS

may be easily removed by the operator, and even the weed seeds may be readily separated from the *clean bolls* by riddling with a coarse sieve of about $\frac{1}{4}$ in. mesh.

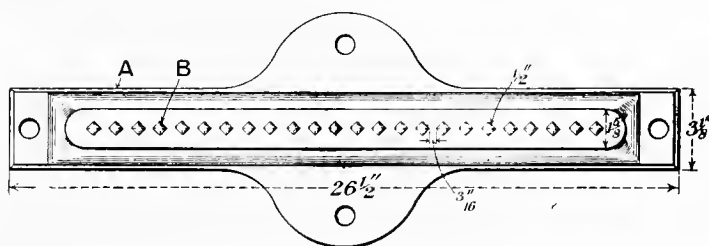
Rippled flax is easy to handle, since there is no interlocking



ELEVATION

FIG. 43

of the seed bolls in any subsequent operation. The rippled straw is easily separated, adjusted, evened up and the root



PLAN.

FIG. 44

ends made "square"; after retting, too, the flax can be spread or gaited with greater expedition and economy.

81. "*Ripple*" Machinery.—The chief features and details of the ripple are illustrated at Figs. 43 and 44, which show an elevation and a plan respectively. The ripple consists of an

iron base A, provided with twenty-four rectangular spaces B into which steel pins C, rectangular in cross section, are inserted and fixed in parallel and vertical positions. The twenty-four pins are each $\frac{1}{2}$ in. diameter, $13\frac{1}{4}$ in. long, $\frac{3}{16}$ in. apart, and set over a distance of 20 in. They taper to a blunt end at the top and where the space is consequently larger and therefore less liable to injure the fibre, when the straw is being driven into the comb. The foundation plate is provided with four bolts so that it can be securely fastened to any convenient plank, which in turn must be mounted securely to a rigid fixture. Some ripples are made to two-thirds of the dimensions given. If the weather is favourable, the rippling is performed in the field, where provision is made to receive the seed bolls as they fall from the ripples, either into a bag, box or sheet, spread under and for as wide a distance around the rippling apparatus as is possible. Fig. 45 is a photographic illustration of war-time volunteer rippers.

If desired two rippers may sit or stand facing each other, and work at one ripple, but a relatively larger amount of work can be done with one rippler to each machine. The rippler takes a handful of flax from the beet—an easy matter if the beets have been crossed diagonally at the time of pulling as previously detailed. Each handful is then freely thrown, fanlike, over the points of the ripple. They must not be driven into the combs since any undue severity is liable to damage the fibre.

First the seed capsules near the ends of the stalks are removed, then the remaining parts are drawn alternately “over” and “under” hand through the teeth of the comb until the bolls are removed. It is advisable rather to leave a few bolls on the stems than to draw the flax too often through the comb, lest by so doing the fibre of the plant may be damaged. An experienced rippler will practically cover the whole of the pins with each throw and remove the seed bolls at two throws after having first removed the bolls from the entangled ends of the straw. This is always all that is



FIG. 42.
TESTING FOR GERMINATION

necessary where the flax is of fine quality, and where the stems only contain a few bolls.

If the rippling is carefully performed, the seed capsules will all be thoroughly removed and the stalks cleaned with the minimum of breakages, but a careless rippler produces a lot of waste. In earlier days three average ripplers could take the seed bolls from a statute acre of fresh pulled flax in one day. Recently an average rippler completely rippled one statute acre of partially dried flax in forty hours.

82. "*Rippling*" Operation.—Each handful of rippled flax is laid down by the rippler at his side, until he has accumulated a sufficient quantity to make an average sized round beet, which is then tied together. If desired, less experienced assistants may be engaged to keep the rippler supplied with handfuls of the unrippled straw and to tie up and take away the finished beets which are now ready for the retting process, or the whole series of operations may easily be performed by boys or girls.

83. *Rotary Ripple*.—Figs. 46 and 47 illustrate an elevation and plan respectively of the essential details of a rotary rippling machine, designed by Mr. W. J. Strain, Moyallon, Portadown, Ireland.

The chief features of the mechanism are as follows: A drum 1 with shaft 2 is mounted and free to rotate in the bearings of the supporting frame 3 as shown. The drum 1 carries two combs, 4 and 4', diametrically opposed to each other. A series of semi-circular bars 5 are compounded in the form of a stationary grid, which latter is so adjusted that each successive bar 5 is fixed equidistant between the respective and contiguous pairs of pins 4. Compounded with each divisional bar 5, are eleven radially-constructed pins 6 whose function it is to offer a restraining action to the pull of the rotary combs 4 and 4'.

The operation of rippling is as follows: The rotary drum 1, with combs 4 and 4', is set in motion. The rippler takes successive handfuls of flax and firmly gripping the straw

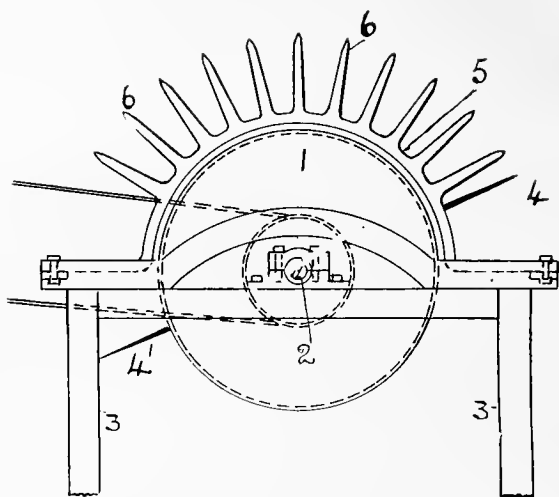


FIG. 46
ELEVATION

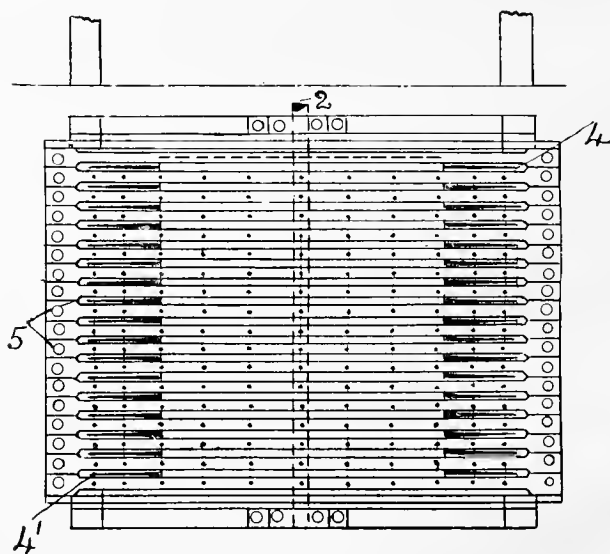


FIG. 47
PLAN

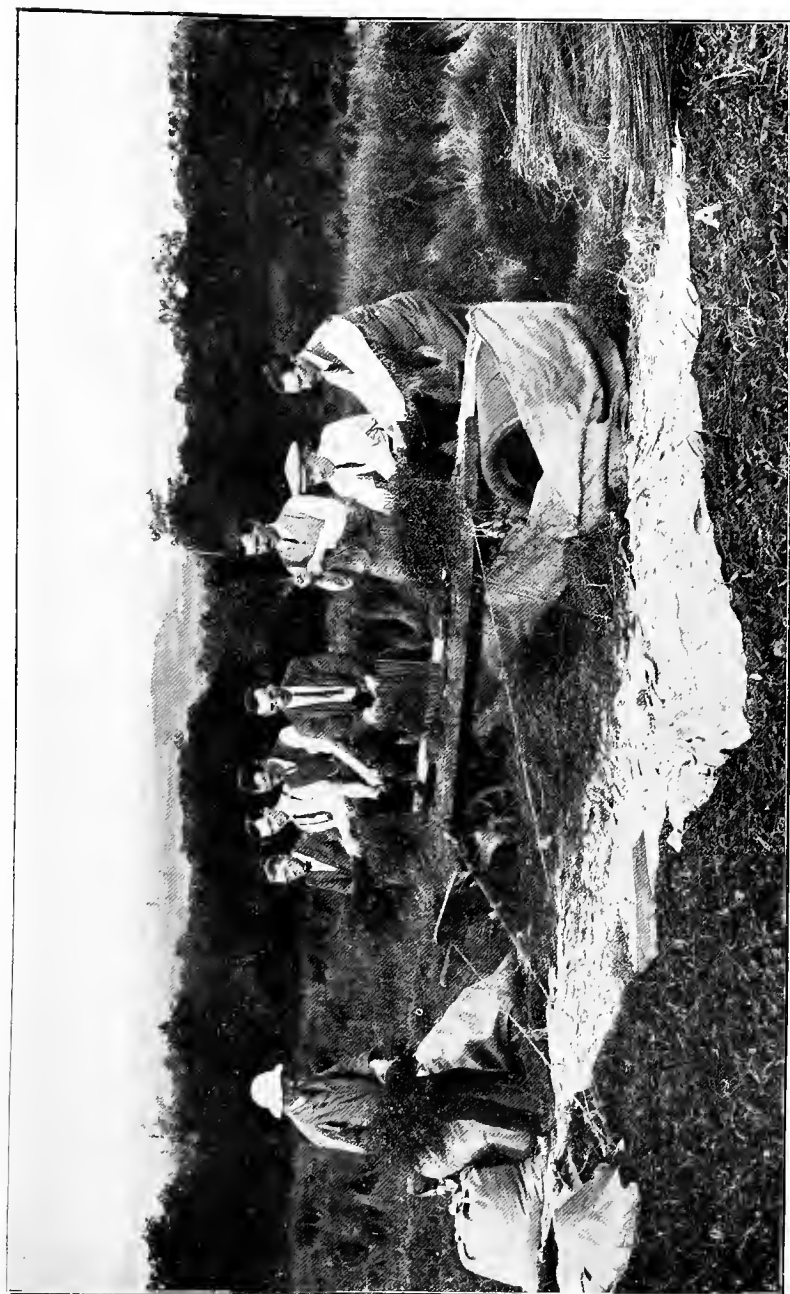


FIG. 45

DESEEDING FLAX STRAW BY HAND--RIPPLING

towards the root ends, freely throws and evenly distributes the tops with the seed bolls over and into the series of fixed pins 6. With the assistance of these pins 6 the operator holds and adjusts each handful of flax to suit the stripping action of the rotary comb.

84. *The Hand "Morston."*—Figs. 48 and 49 illustrate

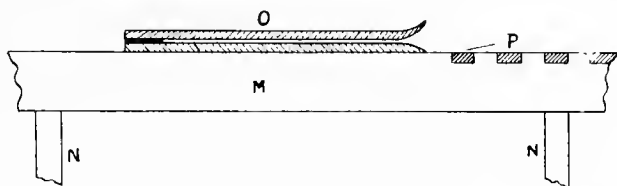


FIG. 48

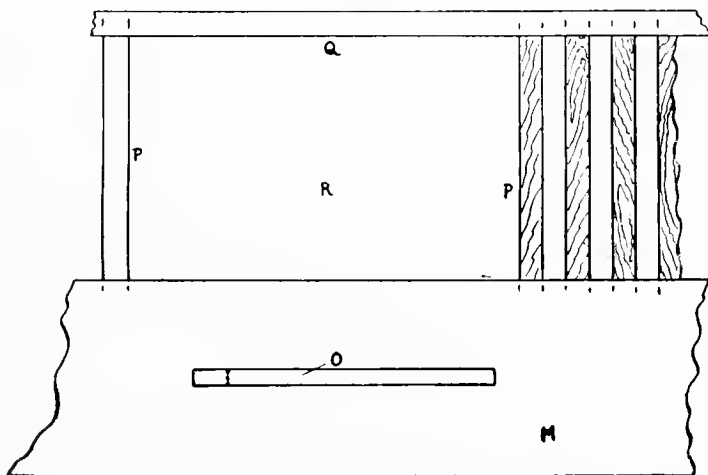


FIG. 49

respectively an elevation and plan of a part of a simple, effective and suggestive arrangement designed and used by Mr. F. Leitch, Belfast, for deseeding, as preferable to the hand ripple.

It consists essentially of a wooden bench M of any length, the legs of which indicated at N, are secured to the bench M. A lower and an upper steel bar O, are adjusted to each other,

in such a manner as to form a groove or sufficient space to allow the flax to be freely thrown in by the hand, but not large enough to permit the seed bolls to pass between them. A series of wooden bars, P, connect the bench M with a long and continuous bar Q, so as to form a space, R, into which the seed bolls fall.

The unrippled straw may be laid on the cross pieces P and from it the operator selects the handfuls and freely throws them into the groove of bar O. The bolls, being on the remote side of O, fall into the recess as the straw is gently pulled towards the worker.

An advantage of this arrangement is that it can be used by boys or girls or any unskilled labour.

85. *Conveyer Belts and Oscillating Comb*.—The Fibre Corporation, Dromara, Ireland, have recently devised a deseeding machine in which the characteristic features are as follows: The flax straw is continuously fed into the nip of a series of conveyer belts, with the heads of the straw and the seed bolls projecting about 1 ft. from the belts. As the flax heads pass a given point an oscillating comb descends, and with its teeth penetrates between the stems of flax and moving outwards at right angles to the direction of the traverse of the conveyer belts and straw, removes practically all the seed bolls.

DESEEDING DRY STRAW

In all cases where the flax has been harvested, with the definite object of saving the seed for subsequent sowing, the straw, together with the seed bolls, is thoroughly dried and stacked as previously explained. The seed bolls may then be readily, and they frequently are, removed by means of a pair or multiple pairs of revolving wooden or steel rollers.

The primary advantage of this principle is its relative speed and the simultaneous removal of the seed bolls and the crushing of same so that the seed is free to drop out though mixed with chaff, leaves, and dust.

An objection is sometimes lodged against this principle

because of the possibility of marking the seed against the hard straw when passing between the rollers. Notwithstanding this possibility, the bulk of the deseeding of dry straw is performed on one or other of several methods in vogue which embody this principle.

86. *Two or Three Rollers.*—Fig. 50 illustrates in elevation a method of deseeding by means of rollers, which may be rotated by hand or power. Two upright gables A and A' support two or three horizontal shafts (usually two) B C D' These are free to rotate in bearings E F G and E' F' G' as

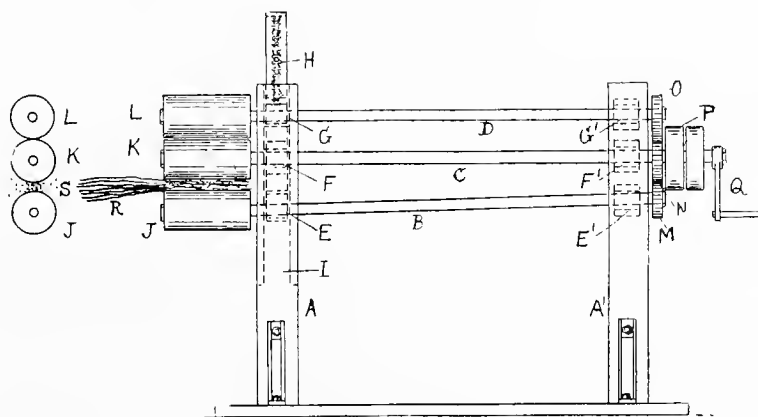


FIG. 50

shown. The bearings F E' F' G' are stationary, while those of E G are free to move up or down, when subjected to slight pressure. The spiral spring H and the steel spring I are adjusted to offer the necessary resistance. Wooden rollers J K L are secured to and near the left terminals of shafts B C D respectively. Spur wheels M N O, containing a like number of teeth, are compounded with these respective shafts, as are also a fast and loose pulley P and a handle lever Q, so that the machine may be turned by hand or power. The flax straw is shown at R and the seed bolls at S.

The process of deseeding and crushing is simple—

1. Where only two rollers, J and K, are used the operator lifts a full beet of straw at a time and repeatedly passes it, boll end first, between the rotating rollers, until he is satisfied that all the bolls are crushed and the seed free.

2. With three rollers in use, the operator first passes the straw between the rollers J and K and then backwards between the ripple rollers K and L. This three-roller arrangement is the device of Mr. A. Williamson, co. Down, Ireland.

87. *Two Single Pairs of Rollers.*—Figs. 51 and 52 show respectively a side and front elevation of a power driven-machine which carries a pair of deseeding rollers at the front and a similar pair at the back of the machine. A B are the deseeding rollers mounted on shafts F G respectively. The shafts are supported and free to rotate in the gables C, and receive motion direct from the motor or line shaft. Equal and uniform motion is maintained between F and G through the medium of the like spur wheels D and E. Flexible pressure is applied to the upper shaft G and rollers B through the medium of the spring and bar H of the ordinary wringing machine type. I and J are vertical supports for the sloping tables K and L.

The operator feeds the flax straw as at K and delivers it when complete on to the bench L from whence it is removed and made up into beets of uniform size.

88. *Multiple Pairs of Rollers.*—This machine is extensively used in some flax districts. It consists of three pairs of rollers on each side of the machine. They stand about 2 ft. 6 in. above the ground, and are near to each other so that the operator can pass the straw through all the three sets of rollers without any break. This is designed to obviate the loss of time occasioned when only a single pair of rollers is used.

Fig. 53 shows a front elevation, Fig. 54 a plan and Fig. 55 a transverse section through the rollers on one side of this machine. Similar numerals in each diagram refer to corresponding details ; 1 and 2 are the first pair of steel rollers and

1' and 2' the duplicate pair, on the opposite side of the machine (Fig. 53). These rollers are compounded with the shafts

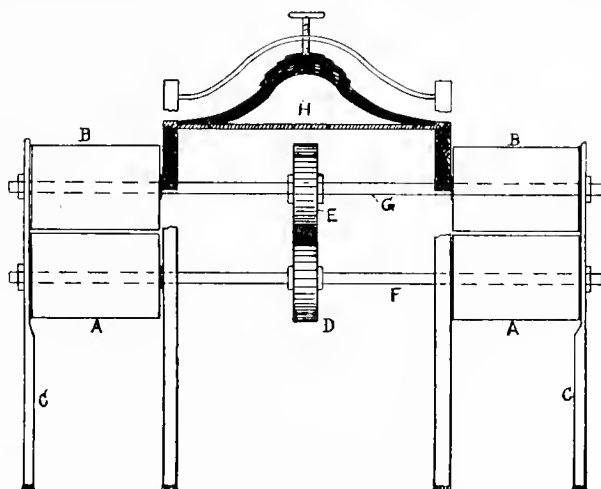


FIG. 51

3 and 4 to which a continuous rotary motion is given. The remaining pairs of rollers are shown at 5 6, 7, 8, and their

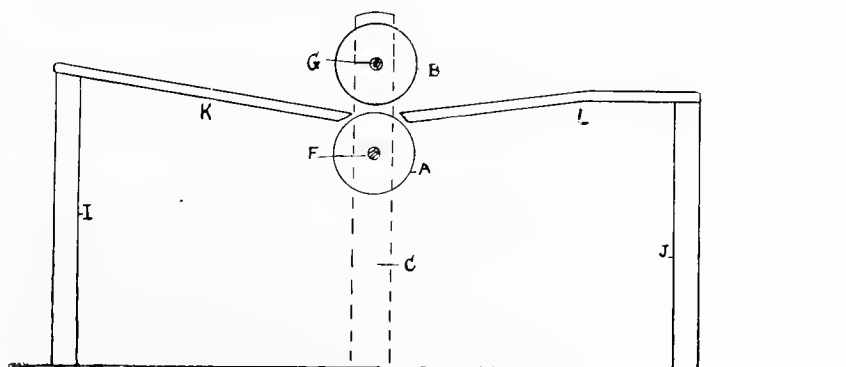


FIG. 52

duplicate top rollers at 6' and 8'. The gables 9 and 10 carry the rotary shafts 3, 4, 13, 14, 15, 16, together with their respective pairs of rollers as shown.

Spiral springs 11 and 12 and their duplicates are adjusted to supply the requisite amount of pressure between the nip of the steel rollers at the time of breaking the bolls and deseeding.

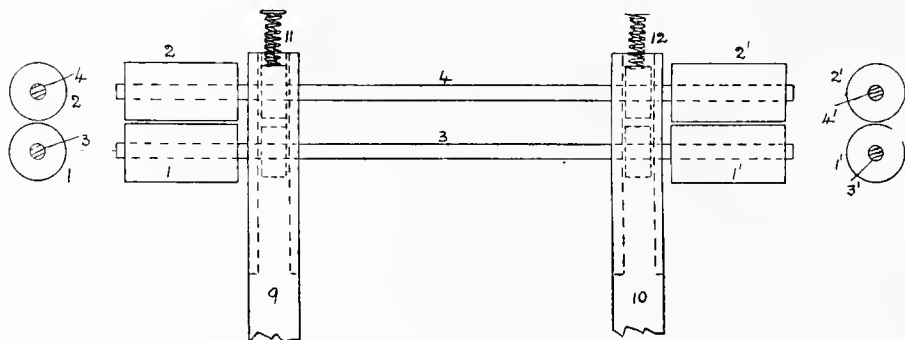


FIG. 53

The work of the operators—one on each side of the machine—simply consists in putting the head of the beet between the contiguous and continuous rotating pairs of rollers.

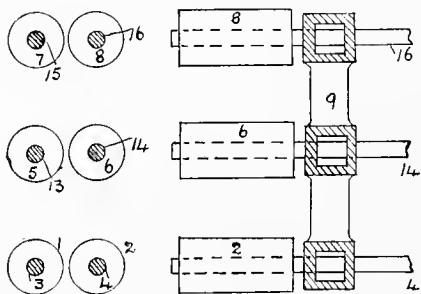


FIG. 55

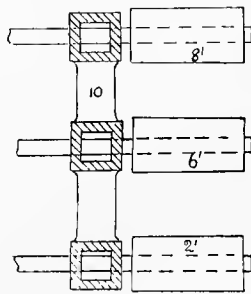


FIG. 54

89. *Greene's Reels*.—Figs. 56 and 57 show the essential features of this machine. The former is a sectional elevation and the latter a plan. The same numerals in each diagram refer to similar parts. 1 and 2 are high speed rotating shafts, on each of which are mounted three iron discs, of which only

5, 6, 7, and 8 are shown. Each reel contains six steel blades, 9 and 10, about 3 ft. long, 2 ft. broad and $\frac{3}{16}$ in. thick, and are rounded at the tips. These blades are compounded with the discs 3 to 8, and consequently rotate with the shafts 1 and 2.

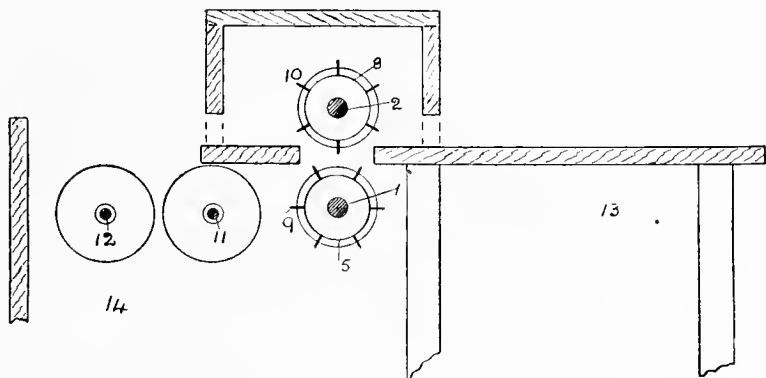


FIG. 56

The function of the reels is to remove the seed bolls by means of the rapid rotating steel blades, which are adjusted to intersect but traverse the same horizontal plane. 11 and 12 is a pair of slightly fluted and slow revolving rollers, the speed of



FIG. 57

the latter being twice that of the former. Their work is to break the deseeded bolls and liberate the seed, which operation is assisted by the rubbing effect generated by the varying speed of the two rollers.

The straw is selected in handfuls off the table 13, and passed over it, into and between the rapidly rotating steel blades of the reels 1 and 2. The lower reel, rotating counter clockwise, removes the bolls from the underside, and the upper reel,

rotating clockwise, removes the bolls from the upper side of the straw. The operator immediately withdraws all the straw which is cleared practically of all the bolls at one operation. The seed bolls then pass forward by gravity, between the fluted pair of rollers 11 and 12 into the box 14, ready for cleaning.

CLEANING THE SEED

If for sowing purposes, the seed must be thoroughly cleaned of all foreign matter, including chaff, leaves, dust, and weed seeds.

If of inferior quality, the bolls may be removed from the straw before being crushed, cleaned from all leaves and dust, and then ground up, seeds and all, into a fine powder or meal ready for mixing in suitable proportions with other feeding stuffs.

After removing the bolls it is usual to give them a preliminary screening so as to extract any short pieces of broken straw that may have accumulated during the operation of deseeding.

The separation of the chaff, leaves, and dust from the seed is usually accomplished by passing the mixture repeatedly through a "Boby" machine, or set of same. The Boby consists essentially of a fan, three sieves, and a suitable exhaust through which the dust and small light leaves may be blown. The chaff is carried forward to a separate exit, while partially cleaned seed falls to the ground or any convenient receptacle. An arrangement is added to this machine for the final operation of cleaning and separating the charlock and other weed seeds from those of the flax. It consists essentially of a series of small washers arranged and free to oscillate upon a series of transverse stationary rods. Supported at right angles to these rods and between the washers, are a number of longitudinal rods which are attached to a reciprocating bar. The reciprocation of this bar causes the washer to oscillate, and thereby turn the flax seed on to its edge, which allows it to pass through the fine sieve of about $\frac{1}{16}$ in. mesh, but the

round charlock seeds and small lumps of soil and other foreign matter are oscillated forward into a separate division.

90. *Separation of Flax Seed into Different Weights.*—Fig. 58 shows in elevation a method for separating the flax seed into groups of different weights and also of removing the chaff, dust, and light weed seeds.

The chief features of this arrangement are a stand or table A, on which is mounted a high pressure fan B (H.P. = $\frac{1}{4}$). C is

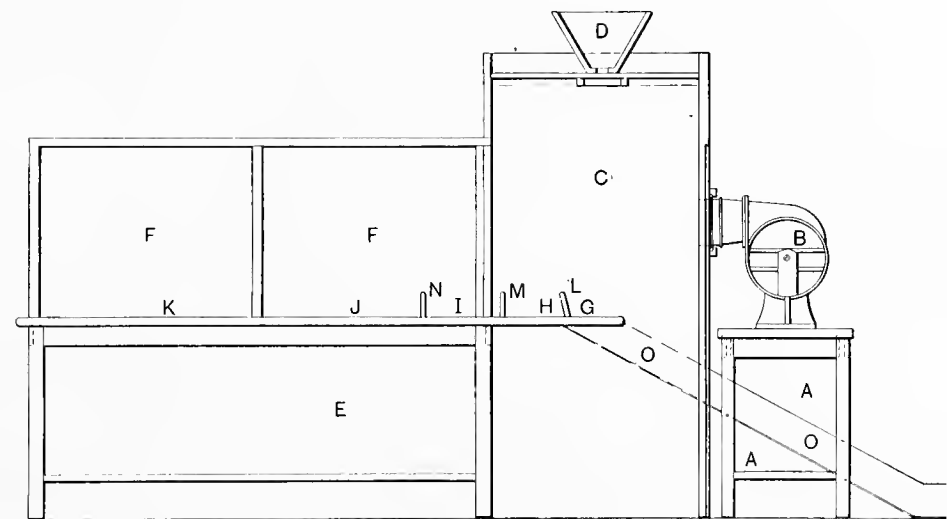


FIG. 58

a large box 6 ft. or more in height and about 2 ft. 6 in. in breadth. D is a box into which the seed is poured and from which its flow is regulated by an aperture in the base. E is a supporting table of any desired length and F an enclosed rectangular chamber about 2 ft. in width and of the same length as table E.

The table top is divided into three or more divisions, G H, I J K, by means of adjustable boards L M N. A "shoot" for the seed is shown at O.

The box D is kept filled with seed to be cleaned or separated.

When the fan is set in motion, the pressure of the wind created, is sufficient not only to blow the chaff, but also the seed, any distance. The pressure can, however, be so regulated that when the seed falls by gravity from D into C the heavy seed, still less affected by the fan than by gravity, continues to fall direct on to the division G and gradually finds its way down the shoot O. Into the division H a lighter class of seed is carried, and into the division I, a still lighter seed and some chaff. Into the division K, the chaff is mostly carried but into J only black chaff—leaves—dust, and the lighter weed seeds are blown. With this arrangement, provision can easily be made for continually collecting the seed, etc., from the separate divisions G H I J K.

It is decidedly advantageous to separate the clean flax seed into groups of different weights, to keep them distinct and to sow them separately.

Fig. 59 shows an arrangement for stacking the undeseeded straw, through the winter, so as to be virtually out of reach of vermin.



FIG. 59

A FLAX STACK OF UNDESEEDED STRAW

CHAPTER XI

RETTING

91.—Functions of Retting. 92.—Experimental Work. 93.—Laboratory Investigations. 94.—Retting Practices. 95.—Pond Retting. 96.—Idiosyncrasies of Flax Retting. 97.—Retting in Sluggish Rivers (Lys). 98.—Twice Retting. 99.—Dew Retting. 100.—Artificial or Warm Water Retting. 101.—The Dromara Fibre Corporation. —Tank Retting. 102.—Legrand's Warm Water Retting. 103.—The Rossi Process of Retting. 104.—Spreading. 105.—Gaiting.

91. Functions of Retting.—The fibres of the flax plant in their natural state are bound to the stem by a *pectinous* compound, a substance which is characteristically gummy or gelatinous.

For commercial purposes it is essential to separate the fibres from the stem, and this object is accomplished by retting and scutching.

The function of retting is to decompose, by *fermentation*, the adhesive substances which bind the fibres to the stem, and simultaneously and sufficiently rot the pith or stem to such an extent that in the subsequent operation of scutching it will break and freely separate from the fibres which are held, and remain in the scutcher's hand.

Fermentation is a chemical action induced by the presence of a ferment. All processes of fermentation, natural decomposition and putrefaction are microbic in origin.

Germ, microbes, micro-organisms and bacteria are synonymous terms which are generally and loosely used to refer to the whole group of minute cells.

The micro-organisms are of various kinds and shapes, and are usually denominated bacteria. The word bacterium literally means a rod.

1. *Bacilli* is a special term used to denote the group which are of *rod-like* shape as distinguished from other shapes. The aerobic and anaerobic bacilli belong to this group.

2. *Cocci* or *micro-cocci* are round or globular in construction.
3. *Spirilla* are shaped like small curved rods.

These three groups include the majority of bacteria, and are classified by bacteriologists among the lower micro-organisms.

A record of the following fundamental data will be found useful for reference when the various subsequent processes of retting are described.

Propagation proceeds according to favourable environment, such as temperature, moisture, medium, and nourishment.

According to Dr. Gerald Leighton, as many as 17,000,000 organisms will arise from a single organism in twenty-four hours. Micro-organisms which induce putrefaction require an average temperature of 20° to 24° C. (68° – 75·2° F.).

Most microbes require an alkaline medium. Some are unable to stand a trace of acidity, though

in flax retting a weak acid solution has been proved to be most satisfactory.

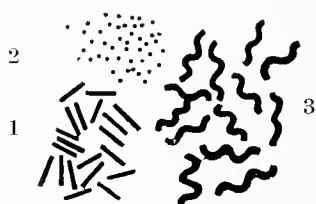
The resisting power of germs to *dryness* varies greatly in the different species.

Some species of bacteria may remain alive, or in suspended animation, in the dry state for very long periods. They do not reproduce in the resting stage but resume activity when the favourable opportunity occurs.

It is important to remember that the particular ferment which is active towards the ingredient of the plant is generally present in the plant itself. In the flax plant the active retting agent is a micro-organism of the bacilli group,—aerobic or anaerobic.

The aerobic bacilli can only live and multiply in a medium containing free and dissolved oxygen.

The anaerobic bacilli flourish only in a medium which is free from oxygen. The anaerobes obtain their food by dissolving



THREE CHARACTERISTIC FORMS
AND GROUPS OF MICRO-
ORGANISMS

the sugar in the pectinous compound which also contains oxygen, but undissolved, hence any oxygen which they may require they are able to produce for themselves. Incidentally it is interesting to note that within twenty-four hours after putting the flax straw into the pond all the free dissolved oxygen is used up or has disappeared; consequently it is assumed that only the anaerobic bacilli continue to live, multiply, and carry on the work of decomposition.

It is advisable to ensure that the required bacteria are present in the plant or in the water in sufficiently large numbers, if the retting is to be perfectly accomplished. "Starters" may be necessary to initiate or accelerate the process. (See also Rossi process, where an aerobic bacillus is the retting agent.)

The propagation of the bacteria in the plant or in the water is accelerated or retarded according to the temperature, chemical conditions, acidity, and alkalinity of the water (water containing a weak solution of acid is preferable).

Fermentation proceeds most rapidly at given known temperatures. It is checked by raising or lowering the temperature above or below this standard.

An increase in the temperature in tank and stagnant water retting not only increases the bacterial activity but results in an increased acidity of the water in the process; hence a constant small flow and change of water reduces or neutralizes it.

92. *Experimental Work.*—Apropos this point, Mr. F. K. Jackson stated in a lecture given at Belfast that the following results had been ascertained from experiments and observations made at Selby. The average acidity in stagnant water at 72° F. varied from 30 to 40 milligrams per litre of liquid. When a flow of water per hour was admitted to replace 0·7 in. depth of water in the tank, the acidity was reduced to 25 milligrams per litre. When the flow was increased to 2½ in. per hour, the acidity fell to 10·9 milligrams per litre, and when

the flow was further increased to $4\frac{1}{2}$ in. per hour the acidity was reduced to 4.5 milligrams per litre.

The temperature of the water between April and October normally varies between 50° F. and 75° F. Experience has repeatedly demonstrated that flax rets sooner and better in warm weather and water than in cold—up to a given point.

Without dogmatizing, it is perhaps safe to state that the advantage gained in time from flax retted in water at higher temperatures than the highest normal summer heat of 80° F. is more than neutralized by the maintenance of that high uniform temperature and the probable reduction in quality and yield of fibre. It is therefore most important to try and establish the maximum artificial temperature at which flax can be retted in the least time and simultaneous with the maintenance of the best yield and quality of fibre.

Under favourable conditions the bacteria not only propagate at an enormous rate during the process of flax retting but the propagation is facilitated when the water is clean, clear, soft, and free from mineral salts in solution, warm, and of a uniform temperature—between 60° and 75° F. for pond and river retting generally produces the most satisfactory results. Usually the water used is stagnant, but under favourable conditions and control it may be gradually changed, during the process, without materially reducing the dissolving action of the water or the bacterial retting agents—retting in the sluggish waters of the river Lys, in Belgium, is an example to wit.

93. *Laboratory Investigations.*—Apropos the subject of retting V. Omeliansky, conducted for purposes of comparison, the following laboratory experiments.

He subjected flax stems (1) to the action of pectin fermentation (flax rust); (2) to cellulose fermentation. The losses in weight due to fermentation by the two different processes were 5.6 per cent. and 22.3 per cent. respectively. Omeliansky also found that under the pectin fermentation, all the pectin substances were destroyed whilst the cellulose remained unchanged. This appears to favour water retting. In the

case of cellulose fermentation most of the cellulose was destroyed, but not all, owing to the products having an injurious action on the fermentation process.

94. *Retting Practices*.—Most of the retting methods in use at the present time are as follows—

1. Retting in ponds of stagnant water.
2. In ponds of water which are slowly changed during the process of retting.
3. In sluggish streams or rivers of which the river Lys is proverbially typical.
4. In tanks filled with warm water, the temperature of which is retained at a uniform degree, (a) with a constant inlet and exit flow, under control; (b) with no replacement of water after the retting starts.
5. Dew retting.
6. Rossi process.

7. Numerous chemical methods have been attempted to rapidly perform the operation of decomposition, but comparatively little progress has been made since the days of Pliny, when the flax was steeped in ponds of water exactly as it is done to-day. The possible and inherent difficulty of *quick* chemical retting lies in the fact that the chemical compound which binds the flax fibres to the stem of the plants is of the same composition as that which retains, in overlapping longitudinal order, the *bundles* of ultimate flax fibres from which the characteristically artificial length of the commercial and scutched form of flax is derived. Any process which separates the flax fibres into their ultimate lengths prior to the final operation of wet spinning is fatal to itself.

95. *Pond Retting*.—The first consideration in pond retting is the supply of suitable water; the second, the position of the pond; and the third, its dimensions.

If only *hard* water is available, *i.e.*, water containing lime or mineral salts in solution, or water rising directly from a spring, then such waters are not suitable. Spring water may, however, be improved for the purpose by filling the retting

pond with the water a few weeks before putting in the flax straw, or a better plan, if circumstances permit, is to run the water into a collecting dam from which the actual retting ponds may be filled as required. The water, during its period of storage, mellows and softens, and experience has universally proved that *soft* water is the best in which to steep flax.

The longer the water has been stored in the pond, the sooner, in a relative sense, will the flax be retted. If the water is good and soft there is little reason to allow it to be stored very long in the pond before steeping the flax.

If the water can be obtained from rivers or other streams which are exposed to the atmosphere for two or three miles of their course it is preferable. The results then obtained are usually satisfactory when the temperature of the water exceeds 60° F.

The position of the pond should therefore be near to a river, brook, or stream, and arranged so that it can be readily filled and easily emptied. If there is any objection to emptying the water of the pond into the nearest stream, it should be run out on to the land or into a sump from which it may gradually filter its way into the nearest stream. It is advisable to dilute the water as it flows from the flax pond by a simultaneous flush of fresh water.

Individual circumstances, facilities, and judgment must be the governing factors for decision and action.

The dimensions of each retting pond should be approximately 36 ft. by 10 ft. by 4 ft. for the produce of each statute acre of flax retted. The sides of the pond should gradually narrow from the top towards the bottom. A clayey soil is preferable. A blue clay tints the flax bluish, a yellow clay imparts a pale yellow and a peaty soil produces a whitish flax.

Once the pond is filled with flax it is not advisable to intermittently permit any surface water within its vicinity to percolate or freely run into and mix with the water in the pond because such action may tend to retard or stop the process

of retting at the points where the fresh water enters, and thus produce an irregularly retted straw. Any tendency in this direction can be avoided by digging a narrow trench about 9 in. deep, a few feet from the edge of the pond.

A small constant supply of soft water is sometimes

FIG. 62



FIG. 61

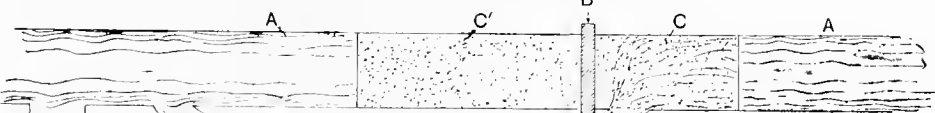
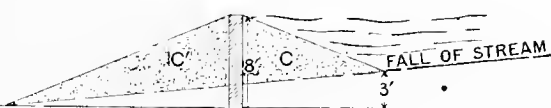


FIG. 60

ARRANGEMENT OF SUPPLY AND ESCAPE
OF WATER FROM THE RETTING PONDS

advantageously allowed to enter the retting pond and a corresponding quantity to escape during retting.

Figs. 60, 61, and 62 illustrate one method of designing and making a retting pond, and overcoming local and natural difficulties; the same letters in each diagram refer to corresponding details.

Two retting ponds (marked Nos. 1 and 2) are required to be made in the position shown, and each to hold an acre of flax. A natural stream (A) runs at right angles to the ponds, but the bed of this stream is 7 ft. below the surface of the water in the proposed ponds, when subsequently filled, and 3 ft. below the bed of the ponds. The fall of the stream being 1 in 3, a wall of puddled clay—taken from the ponds 1 and 2—was made at B, an upper inclined bank at C, and a lower supporting bank at C¹ (Fig. 61).

The accumulation of the water above B and C served as a reservoir from which the ponds could easily be filled.

A "by-wash" D takes away the overflow from C and runs it into the stream A below C¹. The water must never be allowed to run over the wall B.

Narrow cuttings E and F connect ponds 1 and 2 respectively with the by-wash D, and from which either pond can be filled at will. A clay wall is formed at I to increase the storage of water above C. Temporary mud walls are also formed at the head of E and F. The removal of either of these walls permits the accumulated water in D and C to flow into the required pond. A wall G of puddled clay is formed at the head of No. 1 pond, near the base of which a 6 in. drain-pipe is inserted to carry off the water from pond 1, through the natural ditch H into the stream A. The drain-pipe is normally made water-tight, but is removed when it is necessary to empty the pond; simultaneously the wall D is temporarily removed so as to allow the fresh water to freely mix with the escaping retting water. Fig. 63 is a photograph of the two ponds filled with flax and kept under water by means of planks and stones.

The straw should be placed in the pond in an inclined position, about 60°, roots downwards, and each succeeding layer should overlap the previous and contiguous layer by about two-thirds of its length. The beets should be placed regularly and preferably somewhat loose rather than overcrowded. It is a safe rule to give the flax an abundance of water—it is injured more by too little rather than too much. Never allow it to sink to the bottom, keep it in suspension and floating 2 or 3 in. below the surface. The beets may be weighted and kept under the water by stones, sods or planks and cross pieces of timber on which heavy stones or open half-barrels filled with water are placed. This plan is preferable to stones or sods, as by this means it is possible to keep the flax under more uniform control and at the desired suspension. When the retting is nearing completion the flax begins



FIG. 63

FLAX RETTING IN PONDS

(5259) *bot.*, pp. 108 and 109

to sink and then a certain weight lifted from off the planks, allows the beets to rise and still float under the water at the required depth. See also Fig. 63.

The watering should be completed in eight to twelve days, according to the temperature, softness, and purity of the water and the frequent or occasional addition of flood or spring water. When the temperature is less than 60° F. it may require as many as fourteen days to complete the steeping.

The flax is sufficiently retted when the stems readily break without bending, and when the fibre parts easily from the wood or pith.

It is perfectly retted when, after taking off about 3 in. of straw near the middle of the stem, it is possible to pull the flax stem away from the fibres without breaking or leaving any fibres attached to it.

As the process of retting is nearing completion it is necessary, each day, to carefully examine a few straws taken from different parts of the retting pond because the yield and quality of the fibre depend so much on the correctness of the retting. It is inadvisable to be wholly influenced by external factors or formulas of time and temperature—important items notwithstanding. The actual completion of the retting process must be determined by the condition of the straw itself.

The chief difficulty in retting is to decide the exact period when the process is complete, and to have the courage to remove the flax from the water or leave it in a little longer. Preferably it is best to *fully* ret, so that the flax will have as short a time on the grass or in the “gait” as possible, which also ensures that none or very few of the flax fibres will remain adhering to the woody pith in the subsequent operation of scutching. Coarse flax generally rets quicker than fine flax.

It is, however, safer, with the modern Irish system of scutching, to *slightly* under ret than *over* ret, since the former can be partially rectified whilst the latter cannot. In the former case the beets may be allowed to remain somewhat

longer on the "rot" heap or the fault may be rectified during grassing. As the beets are being lifted from the retting pond they should be carefully rinsed in the flax water.

Fig. 64 illustrates the method of removing the flax from the pond, by hand.

96. *Idiosyncrasies of Flax Retting*.—Flax grown from similar seed, precisely in the same field and soil but watered in different places, or in the same pond at different times, will vary as much as 20 to 25 per cent. in price and quality.

The following actual examples are illustrative of this point—

I. A field containing two acres of flax, grown from Canadian Dutch Child flax seed, was divided into two parts, thus—

A. Representing two-thirds of the best part of the crop was retted in the autumn in water at a temperature between 54° and 57° F. The price received per stone was 35s.

B. Representing the remaining third and worst part of the crop was retted the following spring in the same pond and with water from the same source, but containing some of the flax water which had remained in the pond the whole of the winter months. The pond was filled up ready for retting about five weeks before actually required. The yield of flax for B was about 10 per cent. more than for A, and the price received was 37s. per stone, notwithstanding that it was much more difficult to get as good prices in the following summer as it had been the previous autumn, and apart from the fact that the B straw was judged to be inferior to A since it had been exposed to bad weather for a considerable period. At the time, and to all appearance before the retting processes, the yield of B should have been about 10 per cent. less than that of A and about 10 per cent. inferior in quality also.

II. A field of four acres, sown with Irish Dutch Child flax seed, was divided into two parts, thus—

C, representing three parts, was deseeded and retted in the autumn in a stagnant pond of water, the temperature of which varied from 56° to 58° F. The scutched flax was graded and realised 37s. per stone.

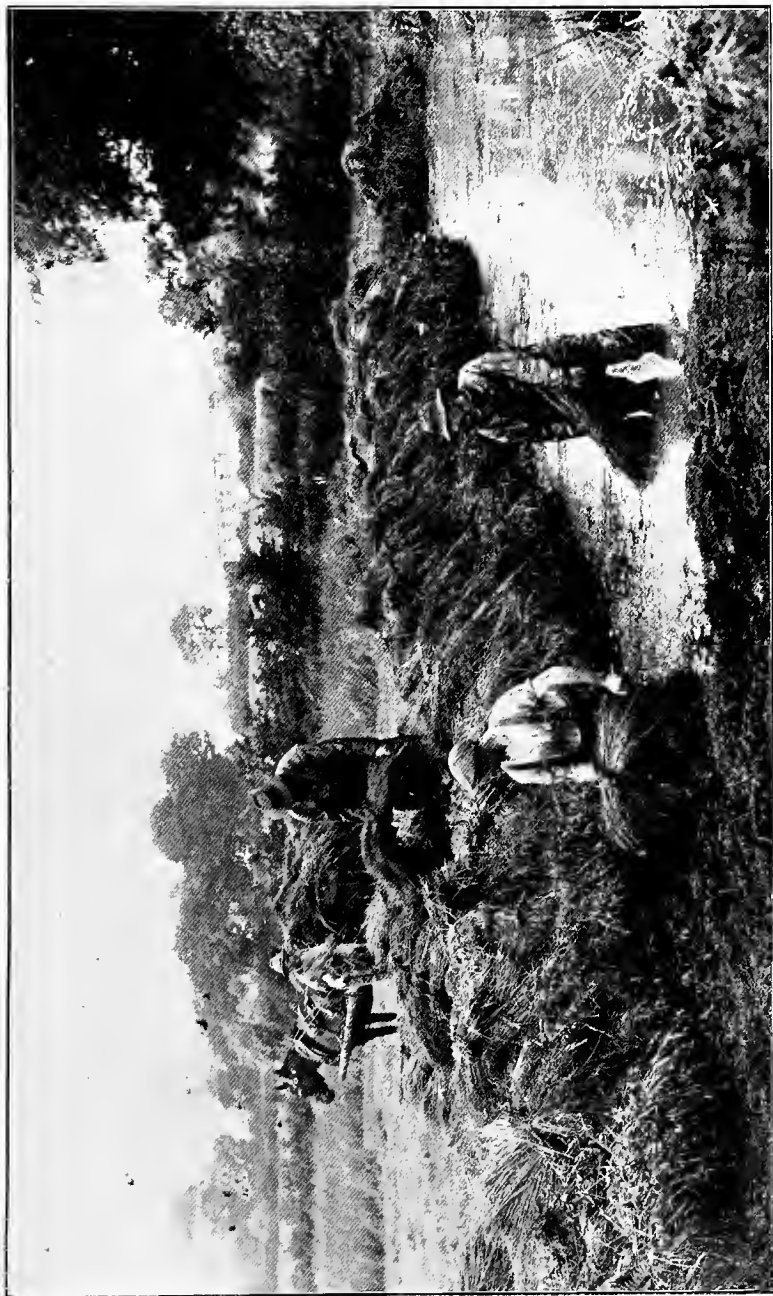


FIG. 64

REMOVING FLAX FROM THE LINT HOLE—IRELAND

D, the remaining and best part of the crop was stacked with the seed bolls attached. This portion was deseeded in the following February and the straw retted during the latter part of May. Water from the same source and stream as for C was run into the retting pond, which contained flax water from the previous autumn retting, equal to about the total volume of water in the pond; the temperature varied from 62° to 68° F. After two days of apparently satisfactory retting, partly through the neglect of an employee and partly through the interference of some boy trespassers, some of the water in the pond escaped. Since it is fundamentally essential that the flax straw must be covered with water, there was no alternative but to run in the necessary quantity of fresh clean water. The immediate result of this action was a temporary stoppage of the fermentation process, and this flax, which should have been perfectly retted in nine days, was still on the "hard" side two or three days later. Partly for experimental purposes the flax, after nearly a fortnight's retting and still on the "hard" side, was spread, dried, and seutched. The quality of this fibre was slightly harsher than that of C, retted in the autumn, and realised 35s. per stone—2s. per stone less than that from the inferior straw which had received no check in the retting.

III. A farmer filled a large flax pond with half of his crop, E. After retting the same he refilled the pond with the remaining half F and with a supply of fresh water; the treatment in both cases was identical. Great, however, was the farmer's surprise when the second portion F realised only 75 per cent. in value to that of his portion E. The only conceivable difference was a possible variation in temperature in the water.

97. *Retting in Sluggish Rivers—(Lys).*—Water retting for very fine flax must be carefully performed—preferably in sluggish streams. The effect of retting in running water is to impart to the flax a light yellow colour, which always commands a higher market price.

The retting of flax in the slow moving waters of the River Lys in Belgium, is the most typical of retting in rivers.

The Lys rises in France, and after flowing through its northern part, it enters and passes through Western Flanders, until it joins the River Scheldt, near Ghent.

The waters of the Lys are very deep and sluggish—the flow is about three quarters of a mile per hour. The water is soft and contains a large amount of organic matter from the towns and villages on its banks, which, together with the enormous and continuous retting carried on, favours the propagation and continuous supply of bacteria (belonging to the putrefactive group) necessary to retting which sufficiently replaces any quantity that may be carried down the stream. This is especially true during the midsummer months as it is well known that the retting is much slower in the earlier days of the retting season.

Steeping commences about the middle of April and continues until the beginning of October. The operation provides employment for hundreds of men to whom the work is a regular trade, and hence they have become very proficient in the art. Flax growers and dealers from near and far send their flax straw to be retted in the River Lys.

The flax is placed in wooden crates, which vary in size and form, generally 12 ft. long, 8, 10 or 12 ft. wide, and 4 ft. deep.

The beets are arranged alternately heads and roots, and packed closely and evenly in the crates. The tops are covered with straw or other material, and tied across in about three places, and the sides with coarse canvas or bagging so that the water oozes rather than flows through the crates.

The filled crates are moved out into the river about 10 or 12 ft. from the bank, and there submerged by weights until the tops are about 3 or 4 in. below the surface of the water. The crates are moored to the bank with strong cords and kept in a floating condition until the retting is completed, which varies from six to nine days, according to the

temperature and condition of the water. The temperature of the water during the retting season varies from 54° to 77° F.

As the flax is removed it is allowed to drip for about a day on the banks of the river. It is then dried and stacked until the following year, when it is scutched or re-retted as pre-determined.

98. *Twice Retting*.—A second retting is usually practised with the flax straw which is judged to contain the best classes of flax fibre. The resultant effects are generally better colour, evenner retting and quality of fibre, which more than compensate for any loss of yield of fibre and expense incurred.

In the Lys district of Belgium, where double retting originated and is now almost exclusively practised, the finest flaxes, after pulling, are set up in long stooks in the field to dry. When thoroughly dry it is put up into stacks or stored away in barns and protected as much as possible from any vermin until the following spring (see Fig. 59). Then, after retting, it is again dried, and if of good quality, it is again stacked until the following spring when it is either grassed or river retted for a second time. In such cases the flax is not ready for the market until almost two years after pulling.

Experience has repeatedly proved that the quality of the flax improves by storing either before or after retting.

The second retting may be, if desired, and frequently is, repeated during the same season. Usually not less than a month is allowed to intervene between the first and second retting. When double retting is practised, the first is naturally of shorter duration than in single retting.

Similar results to the foregoing may be obtained by retting in large lakes of clean warm water where the supply is constant and small. The combined advantages of running and still water may be obtained by arranging for a small constant supply of clean, soft, warm water to run into the retting pond.

99. *Dew Retting*.—The flax, when retted by this method, is spread out thinly and evenly over a field where the grass has been recently and closely cropped. About one to one and

a-half times the area of land on which the flax was produced is required for dew retting.

After leaving a space of about 4 ft. in width across the field the straw should be spread in long straight rows as near to each other as the length of beets will permit, and the root ends should all be in the same straight line. (See illustration, Fig. 65.)

The heat, dew, rain, and sometimes the snow all contribute to carry on the process of fermentation. The time required to complete the retting varies from four to six weeks, according to the moisture, temperature, and general weather conditions. The most suitable months in the year in Ireland are from the beginning of September until the middle of November, although when the flax is left until the following year before retting, the months of March and April are the best available.

After intervals of about a week the rows of flax should be completely turned over. Beginning with the first row, and with the aid of a long straight rod, the flax should be turned on to the space originally and purposely left when spreading out the flax; the second row is then turned over to fall into position left vacant by the first row, and so on with every succeeding row. Additional turnings are necessary after every heavy rainstorm and also every few days in showery weather.

The diversity of experiences and opinions on the subject of dew retting are legion. Some facts, however, have been established—

1. Good results have frequently been and can be obtained when sufficient care is exercised.

2. Flax, retted by this method, when bleached yields a more brilliant white, than does water retted flax.

3. For the foregoing reason dew and water retted flax should be kept separate and distinct throughout the preparing, spinning and weaving processes of manufacture, otherwise the resultant flaxes will appear stripey in the finished fabric.

4. If the hot water in the trough, for the wet spinning of



FIG. 65
SPREADING FLAX

dew retted flaxes, is allowed to remain stationary for some time, the portion of "rove" in the water separates. It is therefore necessary at the end of each day and week to run off the water and again refill when the spinning operation recommences. With water retted flaxes this operation is not necessary.

5. It is the experience of many flax spinners that it is best to put dew retted flax through the processes of preparing, wet spinning, reeling and drying as expeditiously as possible.

6. Dew retting has long been successfully practised in the various regions of Imperial Russia, including Jaroslav, Pskoff, Livonia, Vilna, Kovno, and Petrograd.

7. In Belgium and the western parts of Europe, dew retting of some of the poorer qualities of the straw is sometimes adopted in the autumn and winter months.

8. Generally speaking, though dew retting may be successfully accomplished and good yarns spun from the flax, it is only advisable to adopt this method when retting in ponds or rivers is not available.

100. *Artificial or Warm Water Retting.*—The chief reasons for devising means of artificial or warm water retting are—

1. To reduce the time usually occupied in natural retting in ponds or rivers.

2. To be able to ret all the year round.

3. To ret the flax under controlled conditions.

4. To handle and treat large quantities of straw in centrally situated localities.

Retting in warm water is no new process. In 1846 Schenck patented a method for retting in water between 80° and 90° F. which was practised and found much favour for a time, but it was allowed to drop because it did not pay. A method was adopted, about the same time in U.S.A. of retting in wooden tanks, prepared with perforated false bottoms underneath which a coil of steam pipes was placed, and by which means the water was heated to and maintained at an average

temperature of 90° F. The retting was complete in fifty to seventy hours.

Numerous other methods all embodying the same fundamental principles, have been tried, including the experiments carried out at Mill Isle, co. Down, Ireland, in 1904-5-6, where the water in the tanks was maintained at an average temperature of 72° (68°-77° F.), and provision made for a constant inlet and exit flow of water.

Periodically good fibre results have apparently been obtained from warm water retting but when subjected to commercial and practical tests they have produced an inferior yarn, or the cost has been too great. In many cases the defects have been due to either the use of water of an abnormally high temperature or the too-rapid change of the retting water.

At the present time there are a large number of warm-water retting methods either in actual practice or in course of preparation, *e.g.*—

101. *The Dromara Fibre*

Corporation—Tank Retting.—A series of five ferro-concrete tanks, approximately 60 × 30 × 5 ft., and capable of holding about 10 tons of dry unretted straw, are constructed side by side under the same roof. About 10 tons of water are required for watering each ton of straw. The water is taken from the river, which is of good quality—soft,

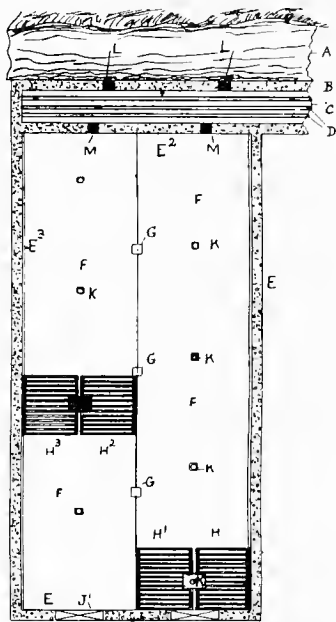


FIG. 66

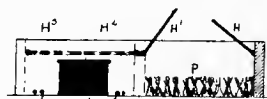


FIG. 67

clean, and clear, and artificially heated to an average temperature of 22° C. (71.6° F.) and supplied to the retting tanks as illustrated at Figs. 66 and 67—a plan and transverse vertical section respectively.

The letters distinguishing the various parts refer to corresponding details in each diagram. A represents the “mill race” in which the water from the river is temporarily stored outside the retting room; B is the wall of the building; C, a storage canal inside the building and running at the head of all the retting vats. C is provided with several steam pipes, D, which rest at the bottom and run the full length of the canal. The pipes, D, are continually charged with exhaust steam received from the engines and boilers. E, E¹, E² and E³ represent the concrete walls of one tank, F. Each tank is divided into two parts by the centrally-placed pillars, G. A series of double gates, H and H¹, run the full length of each tank and are hinged to the wall, E, and the central pillars, G, respectively; likewise the gates, H² and H³, are hinged to the pillars, G, and wall, E³, as shown in the plan. These gates are free to pivot about their respective hinges from a horizontal position when the tank is filled, and to an almost vertical position when the tank is empty or requiring to be cleared of its contents.

Two water-tight sluice gates, J and J¹, are provided for each of the five tanks and are wide enough apart, when open, to admit of the entrance of a small cart filled with flax straw, whenever it is necessary to fill or empty the vats. K represents one of a series of upright rods with a cross plate at the top for holding the gates, H, in a horizontal position during the retting period. L represents valves between the mill race and the warm water canal storage, M the valves between the warm water storage and the vats, and N are valve plugs for releasing any water as desired.

The beets of flax, P, are placed in the tanks by hand, the bottom row is almost vertical, but the second is more inclined from the perpendicular. When the tank is filled with the

straw, the hinged gates, H, H¹, H² and H³, are lowered on to the tops of the beets and their free ends are securely fastened by means of the plates and rod K. All the exit valves are then closed and the warm water from the canal, C, is admitted by opening the valves, M, and a small, constant flow of warm water is admitted into the tank during the retting period. The warm water enters near the surface and is drawn downwards by the releasing of one of the plugs, N, at the front and bottom of the tank which designedly allows the escapement of an equal volume of colder water. The water in the warm reservoir canal, C, is maintained at its maximum height by opening the valves, L, as required.

Usually the retting process is completed in about six days.

102. *Legrand's Warm Water Retting*.—This method of retting was devised and patented by M. Lucien Legrand, Mariaburg-Eckeren, Belgium. It consists essentially of a retting vat, constructed with concrete walls, 7 to 8 ft. deep and 6 in. thick. It is normally made with four separate divisions but is capable of considerable extension.

The flax beets are placed into the chambers, two or three tiers in height, and here maintained between a lower perforated grating, free from accumulation of acid solution, sediment, and products of fermentation, and an upper wooden grating adjusted and fixed at a convenient height to prevent the flax rising above the surface of the water.

Placed immediately above the retting vats is a reservoir tank of warm water, from which the vats are filled and kept supplied at an even temperature. This reservoir tank is in constant communication with a heating apparatus or boiler which, in turn, receives its supply of fresh or cold water from a higher storage tank.

The period of retting varies with the temperature, which may reach 32° C. and the retting may be completed in five days.

The chief features of the apparatus and its construction are illustrated by the following line diagrams—

Fig. 68 illustrates a suggestive method of water and heat supply.

Fig. 69 is a plan of the retting vat.

Fig. 70, a longitudinal section through X X.

Fig. 71, a transverse section through Y Y.

Fig. 72, a front elevation of the retting section.

The same letters in each diagram refer to corresponding parts.

A is a reservoir of any convenient shape and size ; it is combined with a heating apparatus, B, and a second and warm water reservoir, C, preferably placed immediately above the retting vats, D, of which the concrete walls are shown at E. Reinforced girders, F, support the warm water tank, C. A pipe, G, communicates with the tank, C, and supplies water to a conduit, H, consisting of an upper and smaller diameter pipe and a lower and larger diameter pipe, both of which are tapped and provided with oblique orifices. The function of the small pipe is to continuously discharge a fresh supply of warm water during the whole process of retting, while the large pipe is only used at a later period when the retting fermentation is more advanced, and when the foreign substance to be removed has increased considerably in mass and thereby involved a larger displacement of the retting water. The flax straw, I, is placed between the bottom grate, J, and the upper grate, K, in the vat, D. The initial supply is suitably fed from the warm water tank, C, by suitable and convenient sized pipes. The desired temperature is maintained by the supply of fresh warm water through the oblique orifices of one or both pipes in the conduit, H. This water, being warmer than that in the retting vat, naturally rises and rapidly circulates with the greater mass, while the heavier and polluted solutions sink to the bottom, through grid J into the division L from whence it is drawn off by pipes M, which communicate with pipes N and O in turn, connected with a trough, P. The trough, P, then overflows and the contents are emptied through a pipe, Q, and either allowed to run to waste or directed into another vat or section to start the preliminary operation of retting again.

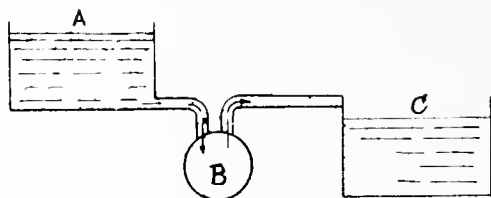


FIG. 68

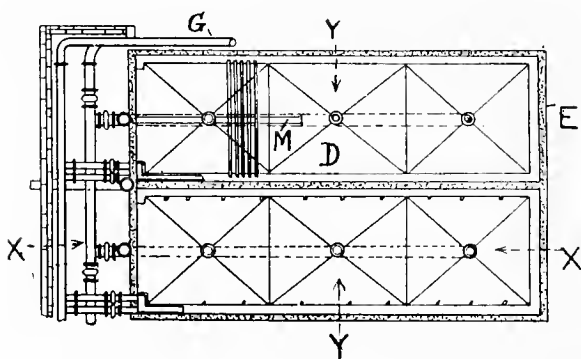


FIG. 69

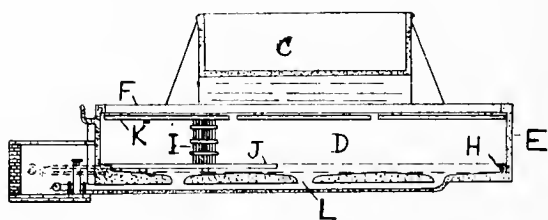


FIG. 70

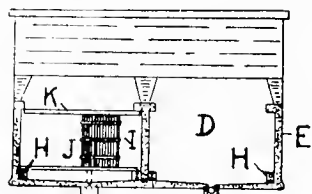


FIG. 71

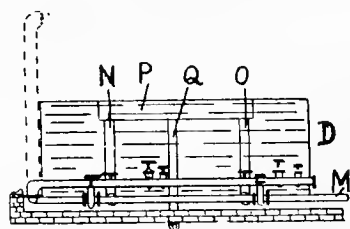


FIG. 72

Controlled warm water retting has undoubtedly come to stay, and many new arrangements for this purpose are constantly being inaugurated.

103. *The Rossi Process of Retting.*—This process was devised by Prof. Rossi, Flax depot, Sarthe Dept., France.

The underlying feature of his principle consists in decomposing the pectinous compounds between the flax fibres and the stem, by a ferment resultant from the action of aerobic bacilli for which the presence of air is indispensable, as distinguished from the usual method of retting where the ferment producing agent is of the anaerobic type, and which can operate in a medium free from air.

The pure culture of aerobic bacilli is prepared by, and obtained from Professor Rossi in small hermetically sealed glass tubes— $2\frac{1}{2}$ to 3 in. in length and $\frac{1}{3}$ by $\frac{1}{2}$ in. diameter. Each tube also contains a small quantity of flax straw and “culture bouillon,” but is kept intact until required for rapid propagation in the incubators. The incubators are zinc tanks, approximately $2\frac{1}{2}$ ft. in height and 2 ft. in width. In these the culture bouillon (food) is prepared. The operation consists in placing a small quantity of flax straw in the tanks and boiling in water for about 50 minutes. The resultant product is a gelatinous substance or “culture bouillon,” sterilized and freed from foreign micro-organisms. The temperature of this bouillon is then allowed to fall to 30°C . (86°F .) at which degree it is maintained. At this stage the pure culture of bacilli from one of the glass tubes is emptied into the incubator.

These conditions of temperature and supply of food are considered by Professor Rossi to be most favourable for a rapid propagation of the added pure culture of aerobic bacilli. The maximum increase in pure culture is completed in a period of 48 hours.

Each incubator contains a sufficient quantity of pure aerobic culture to *immediately start* the retting in a vat containing about ten tons of flax straw. The contents of the

incubators are then run off into open pails which are immediately emptied into the retting vats.

For the above process of retting, a series of four contiguous retting vats of reinforced concrete are prepared. Each vat measures approximately $8 \times 2 \times 3$ metres in length, width and depth respectively, is of about 50 cubic metres capacity, and will hold about 5,000 kilogrammes or 50 tons of water. Ten tons of water capacity is required for every ton of good quality of un-retted dry flax straw packed tightly in the vat. Experience has demonstrated that it is more economical to construct vats of double or larger capacity.

The beets of flax straw may be laid side by side in continuous rows in the vat until it is quite full. The beets are kept in position by adjustably fixing long and narrow pieces of wood across the vats so as to prevent the straw rising above the surface of the water when the vat is subsequently filled.

The water is supplied to the vats through a 3-in. pipe fitted with a valve tap, and requires about five hours to fill. It is raised to and maintained at an average temperature of 28° to 30° C. = $82.4 - 86^{\circ}$ F. The heating of the water is accomplished by blowing steam through the perforations of a 3-in. diameter pipe. The steam pipes are designed to pass through the centre and along the bottom of each side of the vat.

The total area of the perforations in the pipes, either for steam or air, should not exceed 90 per cent. of the area of the cross section of the feeding pipe, and the perforations should increase in number or size towards the terminals of the pipe to ensure an even distribution of the steam or air. At this juncture the pure culture bouillon (nutritive liquid) as originally prepared by Prof. Rossi, is introduced into the vats in sufficient quantity to meet the requirements of any given sized vat and to immediately start and accelerate the process of fermentation.

Subsequent preparations of the culture bouillon can be prepared (from given formula) by any employee of average

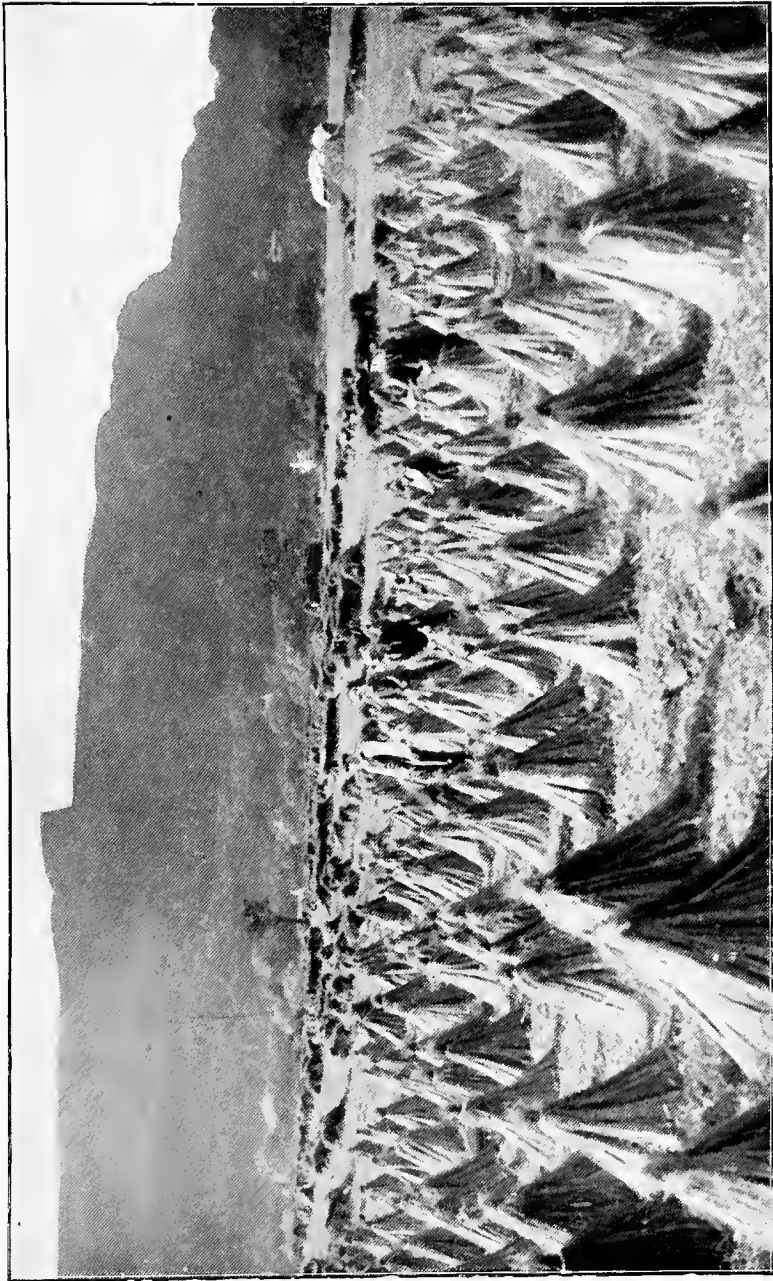


FIG. 73

DRYING RETTED FLAX IN ROUND GAITS

(5259) *ibid.*, pp. 122 and 123;

intelligence. The workman has simply to proceed mechanically and carefully in accordance with the instructions.

The requisite supply of oxygen to sustain the aerobic bacilli is commenced and continued from this stage. The operation is achieved by running along the bottom of each side of the vat a small perforated pipe through which air is continuously forced by an air compressor, capable of supplying 200 litres of air per minute simultaneously to each vat in the series of four. Each vat requires 4 litres of air per cubic metre per minute. The continuous current of air rises and passes through the volume of water until it reaches the surface, where it agitates the water to such an extent as to produce a boiling effect and an abundance of white foam. The foam rises as much as a metre in height and freely overflows from vat to vat.

The retting operation is completed in thirty-six to forty hours, after which the water is run off directly into the river, and since it retains its free oxygen no harm is consequently done to the fish.

The flax is then removed and put into cars, or trucks, which run alongside the vats and the door of the retting room, from which the flax is taken into a drying room to be artificially dried in the winter, but in fine summer weather it is taken on to the grass to be naturally dried.

The artificial drying room is 26 metres (28 yds.) long and open at each end. Through it hot air blasts are continuously forced, and a pair of winged radiating pipes are laid along the floor. About two hours are required to complete the drying. The results achieved by this method are claimed to be equal in quality of fibre and better in yield of scutched flax.

DRYING AFTER RETTING

Whatever method of retting may have been adopted it is necessary to dry the flax and preferably in the open air. Two methods are common : (1) Spreading ; (2) Gaiking.

104. *Spreading*.—Clean lea, or newly-cut grass, is the best place to spread flax. The flax should be well and evenly

spread. (See Fig. 65.) The fibre decomposes more than the woody matter when on the grass, for which reason if it remains too long in that situation it rots, especially in parts, if it is unevenly spread. The flax should be carefully lifted and kept straight with all the root ends square, immediately the drying is complete.

105. *Gaiting*.—This method is illustrated at Fig. 73. The flax is set up in small beets, at first, with their butt ends resting on the ground, and spread out so as to form a cone shape, as shown in the illustration. (See also Fig. 39.) If the weather is unsettled this method is undoubtedly better than spreading.

When the outside of the beet is fairly dry it should be turned, sometimes the outsides of two adjacent beets are put together when nearly dry. The period of drying depends chiefly on the weather; it is essential that the beets should be kept in their erect position.

The flax is ready for taking from the field, after spreading or gaiting, when the fibre rises from the stem.

105a. *Relative Equivalents of Fahrenheit and Centigrade Temperature*—

	Freezing Point.		Boiling Point.
Fahrenheit .	32°	—	212°
Centigrade .	0°	—	100°

∴ Divisions or degrees on the two thermometers

$$= \frac{F \ 180}{C \ 100} = \frac{9 \ F}{5 \ C}$$

$$\text{also } F^{\circ} = \frac{C^{\circ} \ 9}{5} + 32^{\circ}$$

$$\text{and } C^{\circ} = (F^{\circ} - 32^{\circ}) \frac{5}{9}$$

Example.—Given 30° Centigrade convert it to Fahrenheit.

$$\text{Then } F^{\circ} = \frac{30^{\circ} \times 9}{5} + 32 = 86^{\circ}$$

$$\text{and conversely } C^{\circ} = (86 - 32) \frac{5}{9} = 30^{\circ}.$$

CHAPTER XII

SCUTCHING

106.—Scutching Operations. 107.—Hand Scutching. 108.—Flax Straw Butting Machines. 109.—Breaking the Dry Flax Straw. 110.—Breaking Rollers. 111.—Fluted Breaking Rollers. 112.—Horner's Skeleton Drums. 113.—Machine Scutching. 114.—Principle of Scutching and Action of Mechanism. 115.—Buffing and Cleaning. 116.—Details of Scutching Wheels. 117.—Varieties of Adjustment of Blades to Stock. 118.—The Liddell Automatic Grip. 119.—The Automatic Scutcher. 120.—Principle and Operation of Automatic Scutching.

106. **Scutching Operations.**—The scutching of flax is the mechanical and final operation designed to prepare and fit the raw material for the market.

The desired object is to break the internal pith or "boon" and remove it completely from the fibres with as little injury to them as possible. Fig. 74 shows a portion of a scutch mill together with several stacks of dry retted straw ready for scutching.

Three operations are necessary to complete the process of modern scutching. These include—

(a) Breaking, crushing, bruising or "crimping" the flax straw.

(b) Buffing or breaking the boon.

(c) The cleaning or finishing operation.

A "stewart" flax straw butting machine is sometimes advantageously used in conjunction with the rolling machine. A photograph of both these machines is shown at Fig. 75.

107. *Hand Scutching.*—In the hand-scutching days and districts, the dry retted straw was broken or bruised with a wooden mallet, or by other primitive means. A more effective method was introduced, when a single pair of indented or fluted hard wood rollers were constructed and turned by hand, whilst the flax passed through and was broken. A vertical

set of three such rollers was used for this purpose for a time in Ireland and Scotland.

The apparatus used by the hand scutcher was an upright wooden frame or board, into which a notch or cutting was made, about 4 ft. from the ground. This was denominated the "stock." The scutcher's second and remaining implement was a broad, flat, polished, hard wood blade of birch or sycamore.

With these primitive tools at his hand, the scutcher selected a handful of straw, usually called a "strick," and with his left hand placed it in the notch of the stock and there held it firmly, turning it over as subsequently required. Simultaneously, in his right hand, the scutcher held the scutching blade and repeatedly beat the flax until all the broken boon was completely removed. Any particles remaining attached to the fibres were technically denominated "shove." In proportion as these shoves are removed from, or adhere to, the scutched flax, so it is classified as "clean" or "dirty."

A good flax scutcher could scutch about one stone of clean correctly retted flax straw per day.

108. *Flax Straw Butting Machine*.—Fig. 76 is a line diagram which illustrates the main features of Mr. J. W. Stewart's flax straw leveller. The advantage of having the root ends of the straw all "square" is so well known as to require no justification for the introduction and description of this ingenious and simple device.

A is a wooden framework, B an extension of same, C is a fixed support for the spiked bar, F, to which a lateral oscillating motion is given. D is a stationary sloping back with cross-bars, E, against which the flax straw rests. F shows one of a series of spikes, whose function is to keep the straw from falling sideways. G, with the extension, I, is an inclined table pivoted at H and free to oscillate about this pivot, through the medium of the link J and crank L.

As the table I vibrates, the flax straw placed upon it receives



FIG. 74

PORTION OF A FLAX SCUTCHING MILL AND STACKS OF FLAX

(5239) *loc. pp. 126 and 127*

a gentle shaking, so that the individual straws are free to fall by gravity all to the same level.

109. *Breaking the Dry Flax Straw.*—When it is considered that the flax fibres surround the hard woody central part of

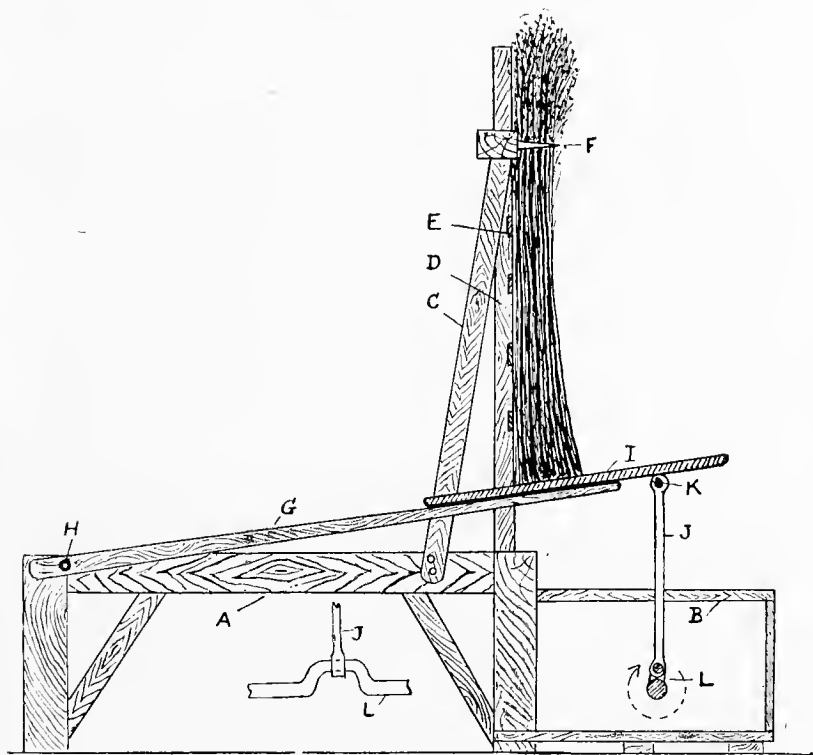


FIG. 76

the straw, it is evident that the greatest care must be taken to avoid any injury to the fibres, when breaking the boon. The more effectually the boon is broken before exposing the flax to the scutching blades, the greater will be the output and the larger the yield of scutched flax per ton of straw, and the cleaner and better the quality. Various mechanical devices have been conceived, including numerous modifications,

numbers, and arrangements of pairs of fluted rollers or their equivalents. In some instances the surface speed of all the rollers is the same, in others a very slight lead is given to the flax as it nears the finishing end. In most machines the rotation of the fluted rollers is uniform and forward, in some, however, the motion is alternately forward and backward, but with a greater forward motion. In one instance a set of rotating and intersecting steel bars or skeleton drums was employed.

But whatever mechanical method is adopted and however perfect that contrivance may be, if the flax is hard and coarse, and badly watered, it will not yield more than two-thirds or a half of clean scutched flax as compared with a similar quantity of perfectly retted and dried flax.

110. *Breaking Rollers*.—At the present time the machines most generally used for breaking the woody pith consists of a series of pairs of fluted iron rollers arranged in a horizontal plane, some rotated by bevel and others by spur-toothed gearing. The rollers of the different machines are approximately 3 ft. long and 6 to 8 in. in diameter. The “flutes” in some machines are $\frac{1}{8}$ to $\frac{3}{16}$ in. “sharp” and $\frac{1}{2}$ to $\frac{7}{8}$ in. deep. On some machines the pitch is $\frac{7}{8}$ in. at the feeding end and is gradually reduced to $\frac{1}{2}$ in. at the finishing end, in which case too, it is proportionately shallower.

In some machines the pitch is $1\frac{3}{4}$ in. at the feed and gradually reduced to $\frac{5}{8}$ in. at the finish. The object in varying the pitch of the flutes is to break the wood in the greatest possible number of places.

In all cases the bottom fluted roller is positively driven and the top one by friction. Pressure is applied to the top rollers by means of springs, weights, and levers. Rubber cushions are sometimes fixed above the springs, for the purpose of causing a slight yield in the pressure whenever any hard substance is associated with the flax straw.

111. *Fluted Breaking Rollers*.—Fig. 77 is a plan showing seven pairs of fluted rollers with bevel gear method of driving same.



FIG. 75

FLAX STRAW BREAKERS AND LEVELLERS

(5250) *loc. pp. 128 and 129*

Fig. 78 is a front elevation of one pair of rollers.

Fig. 79 shows the elevation of a part transverse section of the fluted rollers, between which the flax straw is broken.

The numerals in each diagram refer to corresponding parts. The fast and loose pulleys indicated at 1, are carried by the low shaft 2. From the shaft, motion is conveyed to the two sides of shafts 3 and 4 which carry the driving bevels 5 and 6 and their duplicates respectively. The teeth of the

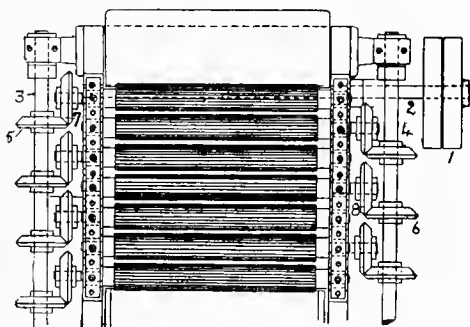


FIG. 77

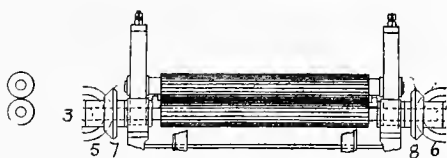


FIG. 78

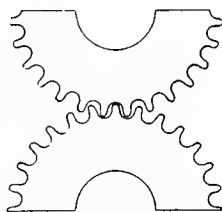


FIG. 79

driving bevels 5 and 6 intermesh with the teeth of the respective driven bevels 7 and 8 on the lower fluted rollers. The diameters, gearing and surface speeds of each pair of rollers are the same respectively.

The flax straw is spread on to a flat table in front of the "feed" with the root ends towards the first pair of fluted rollers. They take in the flax—root end first—and pass it on to the next and successive pair of rollers, and so on until it issues from the last pair completely bruised.

112. *Horner's Skeleton Drums*.—Some years ago this arrangement was devised and patented by Mr. John Horner, Belfast. The machine was manufactured and used in Austria. It was constructed with the object of breaking the boon in as many places as possible without the possibility of bruising it, as was often the case, the inventor believed, with the use of fluted rollers.

The machine consists essentially of ten pairs of skeleton

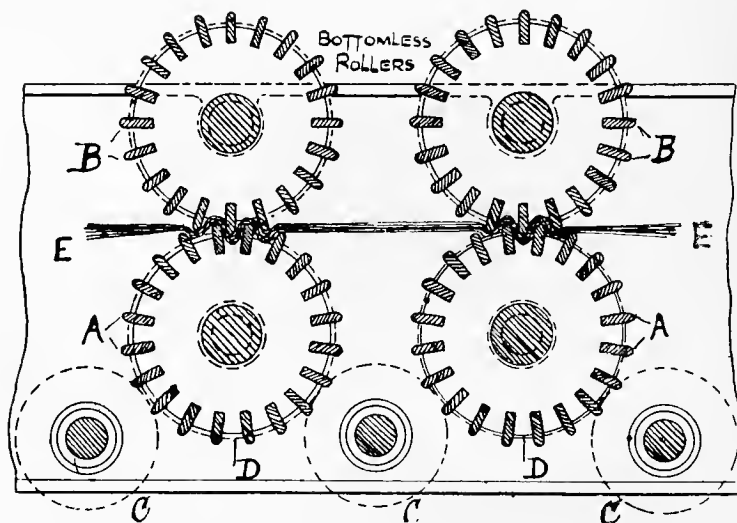


FIG. 80

drums or rings, into the peripheries of which a number of bevelled steel blades are fixed across the full width of the drum thus leaving practically no bottom between the teeth for the boon and fibre to bruise against. The upper and lower drums are carried in fixed bearings. The pitch of the teeth is coarse at the commencement but increasingly fine towards the delivery end. The resultant action is to break the boon without crushing or bruising the material. The invention is interesting and suggestive because it embodies a fundamentally new principle.

Fig. 80 shows a transverse section of two pairs of skeleton

drums. A and B indicate the steel blades or teeth in the lower and upper skeleton drums respectively; C C are the spur wheels which communicate motion through spur wheels D combined with the bottom drums. E shows a portion of the flax straw passing between the rotary blades.

113. *Machine Scutching*.—In machine scutching, a fixed stock is required, as for hand scutching. Several scutching blades are attached to a rotary wheel mounted on a long driving shaft, according to the number of scutch wheels

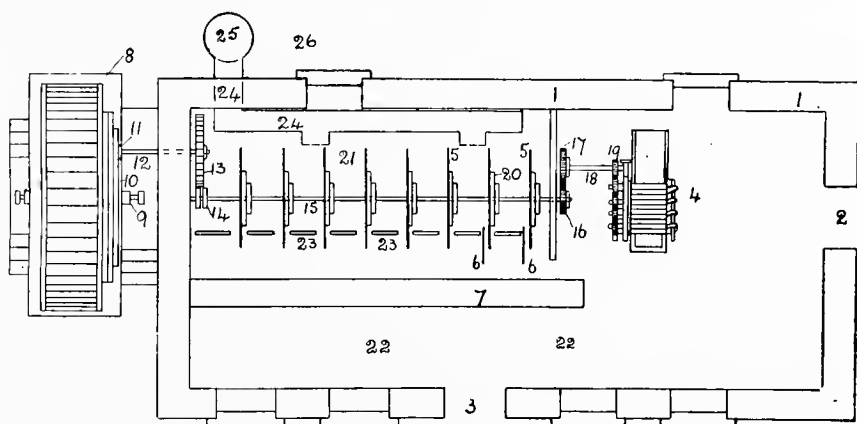


FIG. 81

required. Scutch mills containing 4, 6, 8, and 12 wheels are common, but the tendency is to centralize the scutching operation, and mills are now being constructed to hold 60, 100 and more wheels.

Fig. 81 shows a plan for eight scutch wheels, Irish pattern, one rolling machine and the water wheel from which the power is received.

Fig. 82 shows a side elevation of one of the scutching wheels and the "stock."

Fig. 83, a front elevation of same.

Figs. 84, 85, 86, and 87 indicate a few of the possible and different methods of setting the blades in relation to the stock.

1 represents the walls of the building, 2 the entrance, and 3 the exit, 4 the straw breaker, 5 the scutch wheels, 6 the stock, and 7 the table on which the operative temporarily places the parcels and handfuls of flax. The water wheel, 8, is constructed on the shaft 9, which is free to rotate in suitable bearings. Compounded with the water wheel is a large spur wheel 10, which gears into and drives a small pinion wheel 11 compounded with a short shaft 12, which goes through the end wall into the interior of the building, where the teeth of a large spur-driving wheel 13 intermesh with the spur wheel 14, securely keyed to the scutching shaft 15. This shaft also carries a spur pinion 16, which in turn gears into and drives a spur pinion 17 on shaft 18. Shaft 18 carries a spur pinion 19, which communicates through spur or bevel gears the requisite rotary motion to the fluted rollers. The rims 20 carry the scutching blades and shaft 15 operates completely within the tow box or room 21, which is kept strictly separate from the room 22 where the scutchers work, by the partition 23, which extends from the floor to the ceiling. The dust from the tow room is extracted by means of a fan through the duct and dust conveyer 24, placed at a suitable height, and then through the building to a wide open-mouthed hood placed immediately over the stream of water that flows from the water wheel.

114. *Principle of Scutching and Action of Mechanism.*—Motion is communicated from the rotary water wheel 8 to the scutch blades 5 and the flax breaker 4, through the specified parts 9 to 20 inclusive. The Irish blades, which vary from 6 ft. to 6 ft. 6 in. in total circumference, rotate from 200 to 260 times per minute. The flax is held by the scutcher in the groove of the stock, as in hand scutching; the revolving blades strike the flax in rapid succession, the scutcher taking care to keep his hand close and firmly against the stock all the time, but on the side remote from the scutching blades. The stand for each worker is carefully protected so that there is little fear of any danger to a careful person. The operator

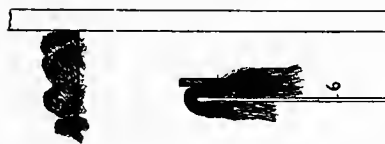


Fig. 83

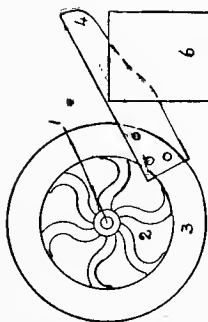


Fig. 87

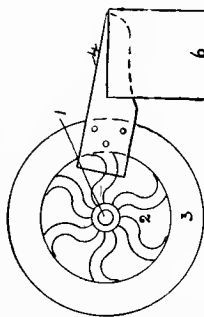


Fig. 84

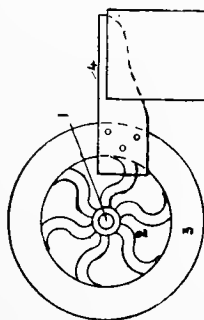


Fig. 82

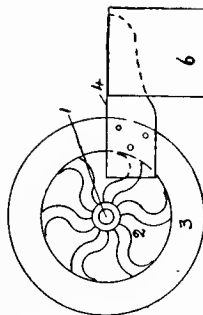


Fig. 85

takes a handful or strick of straw and presents the root ends first to the rotating blades—the iron plate, or stock, protects his hand. When this end of the flax is judged to have been sufficiently struck with the blades, the head end of the flax is presented and held, or twisted over, until the blades have acted sufficiently and equally on all parts of the “strick.”

115. *Buffing and Cleaning*.—It is usual to divide the labour of scutching each strick of flax between two persons—a buffer and a cleaner. The chief difference between buffing and cleaning is the necessity for a slight difference in the severity of the treatment involving a difference (1) of setting the blades nearer or more remote from the stock, and (2) striking the strick square, soon or late. Upon these small technical details there are endless differences of opinion and practice.

It is usual and necessary to set the blades to strike the strick of flax from $\frac{7}{8}$ in. to $1\frac{1}{4}$ in. distance, clear of the stock for the cleaner and $\frac{1}{2}$ in. to $\frac{5}{8}$ in. for the buffer.

The buffer takes up a strick of flax and presents it to the blades until both ends have received a sufficient number of strokes. He then lays it on the table 7 (Fig. 81) and repeats the operation with each successive strick of broken flax straw.

The cleaner or finisher takes up the lots prepared by the buffer, and after repeating the same process as the buffer—root end first—he lays his first lot down before finishing the top end and cleans the root end of a second strick, after which he puts the first and second lot together for the top end and cleans them as one strick.

The finished scutched flax is made up into handfuls of about 1 lb. each, and these are made into bundles of 1 or 2 stones each and tied in three or four places.

A mill with eight stands and one breaker should scutch about 60 stones of flax per day, and give employment to ten persons, including the two breakers.

116. *Details of Scutching Wheels*.—Two types of scutching wheels are in general use, viz., Irish and Belgium. These are

illustrated at Figs. 88 and 89 respectively. The Irish scutch wheel is constructed with an iron rim 3, usually about 3 ft. in diameter and mounted on a steel driving shaft 1 about $2\frac{1}{2}$ to 3 in. in diameter. A series of five, six or seven strong and

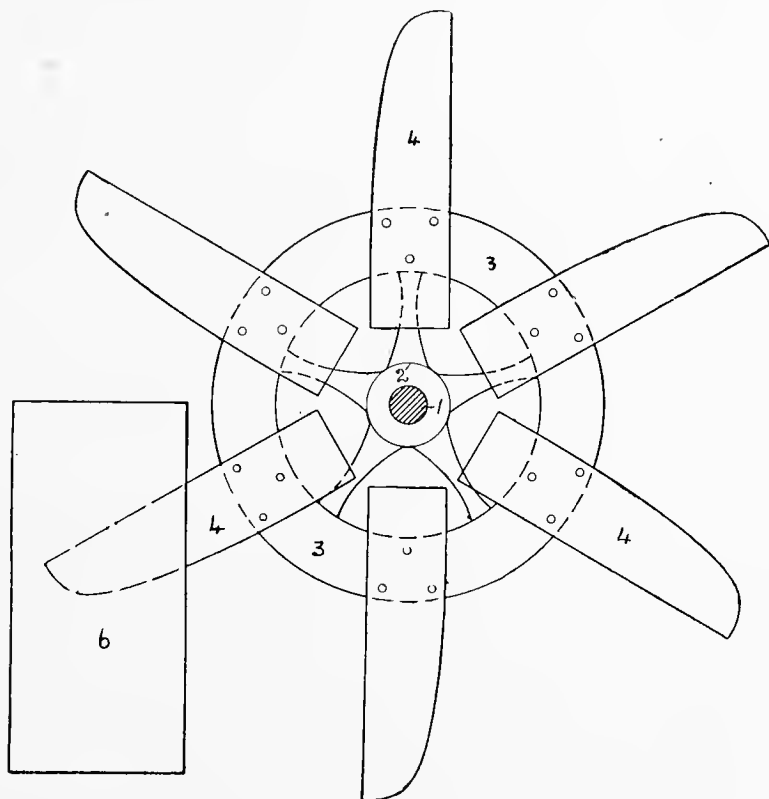


FIG. 88

hard wooden blades of sycamore or birch 4 are bolted to the rim 3, at such an angle as suits the idea of the scutcher. These blades are about 30 to 32 in. in length, and are generally adjusted to project from 18 to 20 in. beyond the periphery of the rim, hence the full diameter of the Irish scutch wheel is about 6 ft. The blades are $\frac{7}{8}$ to $1\frac{1}{4}$ in. in thickness, but

these are reduced and bevelled, on the striking side, to a much finer edge; the width is 6 to 7 in. but tapered to 3 or 4 ins. at the point.

The reductions and bevelling vary considerably, and are

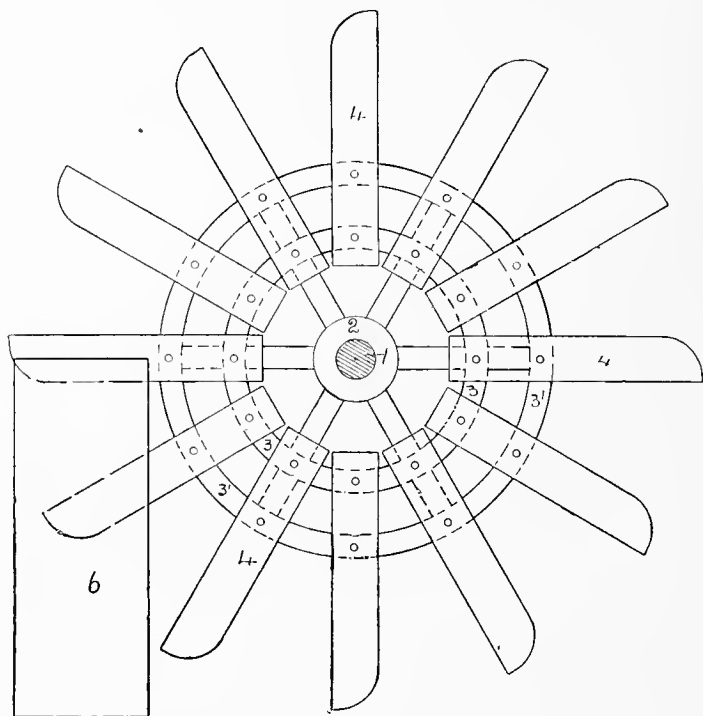


FIG. 89

usually performed by the scutchers themselves, and in accordance with their own ideas.

The blades are adjusted to the stock, from $\frac{5}{8}$ to $\frac{1}{2}$ in. for buffing and 1 to $1\frac{1}{4}$ in. for finishing and cleaning, according to the quality of the material.

The Belgian scutch wheel is constructed with twelve blades, each 27 in. long and projecting about 12 in. beyond the periphery of the outer of two steel rings to which they are adjusted and attached. These rings are riveted to an iron

boss 2, in turn keyed fast to a steel shaft 1, $2\frac{1}{4}$ ins. in diameter. The blades 4, which are sometimes made of polished walnut, are $5\frac{1}{4}$ in. wide but taper to $4\frac{1}{4}$ in. at the point. They are $\frac{1}{8}$ in. to $\frac{3}{16}$ in. thick, but are rounded off or bevelled on both sides of the striking edge for buffing, but only on the side remote from the operator in the cleaning blades. The buffing blades are set, an average of $\frac{3}{8}$ in. and the cleaning blades $\frac{1}{2}$ in. from the stock. The speed of the shaft is from 160 to 200 revolutions per minute, but in special cases as many as 220 revolutions are made.

117. *Varieties of Adjustment of Blades to Stock.*—The stock of wood or iron is adjusted and fixed at a convenient height for the scutcher to operate without any undue bending of his back. The top of the stock and position of the flax is generally in the same plane as the centre of the scutching wheels and shaft, see Fig. 82.

The scutching blades are bolted to the rim in fixed positions so as to strike the strick of flax presented by the scutcher, with a pull or a push, or square, according to the idea and intention or otherwise of the scutcher.

Apropos, this important point, five examples selected from modern practice are illustrated by the simple line diagrams, shown at Figs. 82 to 87. The numerals 6, 4, 30, and 11 respectively represent the stock, blades, rim, and shaft.

In Fig. 82 the scutching blade 4 is "square," or in other words, the top edge of the blade is parallel or square with the top edge of the stock. This is normal and possibly the most scientific position.

In Fig. 84 the nose, or extreme top point of the scutching blade, is shown to be in the same plane as the top edge of the stock, when simultaneously, the top of the blade at the rear top edge of the stock is 3 in. higher.

This adjustment was used for buffing, and the modified adjustment, as shown at Fig. 85, was used in the same establishment for cleaning.

In the illustration, Fig. 86, the extreme top point of the

scutching blade is 3 in. higher than the top of the stock, when simultaneously the top of the blade is in the same plane as the rear top edge of the stock to which it is adjacent. This adjustment was used for scutching at the buffing operation. In the same establishment, for scutching tow, the extreme top point of the scutching blade was 9 in. higher than the top of the stock, as is shown at Fig. 87.

For purposes of comparison, the principles embodied in the adjustments, as at Figs. 84 and 86, are diametrically opposed.

As soon as the flax is struck, as at Fig. 84, it has a tendency to be drawn inwards—away from the operator—and as a consequence, his work is made easier.

In Fig. 86, the tendency of the blade, on striking the flax, is to push it outwards, and the scutcher has, therefore, to neutralize this by holding the flax inwards.

In each of the illustrations given, the centre of the shaft is in the same plane as the top of the stock, and the adjustments are all obtained by altering the position and angle of the blade with that of the stock. Unfortunately the holes for any given adjustment of blades have to be bored separately into the rim of the wheel.

A much better plan and arrangement would be to have slot holes 3 or 4 in. long, cast in the rim and concentric with its centre; these would then facilitate the adjustments either for experimental or periodical changes.

An alternative arrangement for obtaining the late or early sloping strike may be got by raising or lowering the stock over which the flax is held, or by adjusting the flax nearer or more remote from the blades—all with the object of enabling the scutcher to temper or humour the work as he pleases.

118. *The Liddell Automatic Grip*.—This device, patented by Sir Robert Liddell, D.L., a large grower of flax, Donacloney, co. Down, Ireland, was designed primarily to meet the difficulty of securing a sufficient number of experienced flax scutchers, and incidentally, to reduce or minimise the danger of hand scutching.

These difficulties were not only overcome but a little experience soon demonstrated that any person of average intelligence and ability, and even without previous experience, could, with the aid of the Automatic Grip, soon scutch flax as effectively and expeditiously as the experienced scutcher who still adhered to the more dangerous practice of holding the flax by hand closely and firmly against the stock and the rapidly rotating blades of the scutch wheel.

To cite an interesting experience: Two good scutchers, one buffer, and one cleaner, completed 10 stones of scutched flax in a given unit of time by the usual method. One intelligent youth, 16 years of age, in the same unit of time scutched 6 stones with the aid of the automatic gripping device.

Fig. 90 shows a side elevation of the gripping mechanism, which, in its complete and present condition, is ready for attachment to the stock of any of the existing scutching machines.

A is a supporting plate to which all the details of the mechanism are attached. B is a bracket lever, supported on, and free to oscillate about, a stud C, fixed in and near the base of the plate A. At the top of the bracket lever B a lower jaw D is set-screwed and grooved as shown in the supplementary detail sketch to the right. An upper gripping jaw E of right-angled shape is constructed with a depression or tongue, as indicated; the vertical arm of the jaw E is adjusted and free to rise and fall in contact with the back flat side of the right arm of lever B. A steel plate G, set-screwed to both sides of the lever arm B, serves to keep the vertical arm E in sliding contact with that of B.

Near the base of the vertical arm of E a swivel link H connects the base of E with the right arm of a balk lever I; this lever is pivoted on a stud J fixed in the bracket lever B; the left arm of lever I supports an adjustable weight K.

A stud L, fixed in the right arm of lever I, passes through, and is free to move radially in the groove M of the free end of

a simple lever N, which is pivoted on a stud O fixed near the base of the supporting plate A.

A strong spiral spring P, adjustably combines the stud E with a projecting "ear" Q, near the fulcrum of lever N.

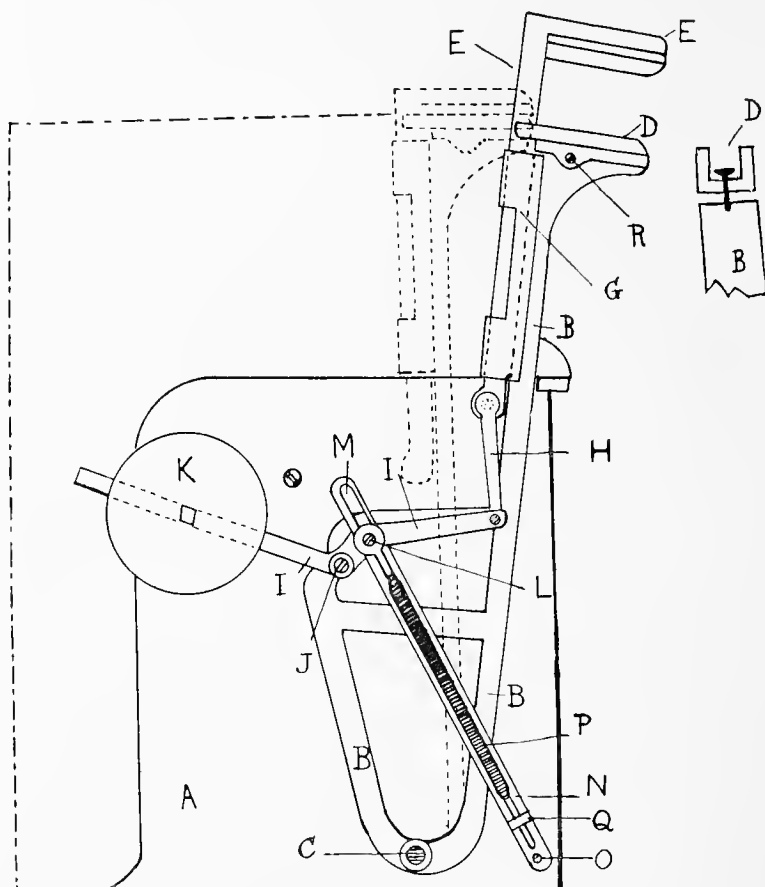


FIG. 90

A smooth hand stud R is fixed near the top of the bracket B. It is about 4 in. long and projects outwards at right angles to lever B, and is the part which the operator grasps to oscillate the lever B, clockwise or counter clockwise.

The resultant action of the mechanism is as follows: The operator places the strick of flax to be scutched between the open jaws of D and E with one hand, and with the other he grasps the stud R and simultaneously moves the lever arm B counter clockwise. The effect of this movement is to gradually increase the radial distance between the studs O and J, which also tends to increase the radial distance between the studs O and L; the groove M facilitates this, but the strong spiral spring P operates to neutralize the action and to restrain any radial movement of the stud L in the groove M, and simultaneously slightly oscillate the stud L, together with the lever I, clockwise about the stud J.

Consequently the downward movement of the right arm of lever I, operating through link H, pulls the upper jaw E downwards into suitable gripping contact with the lower jaw D. The left arm of lever I, with the weight of K, simultaneously rises into a position of accumulated potential energy ready to operate in assisting to automatically open the jaws as soon as the lever B is moved clockwise to reverse the foregoing motions. When the lever B is moved counter-clockwise the grip is closed, as shown by the dotted lines in the figure, and the flax between them is then in operative contact with the revolving scutching blades.

119. *The Automatic Scutcher*.—This machine was conceived, designed, and patented by the Fibre Corporation, Dromara, co. Down, Ireland, and is now used and manufactured by them.

The characteristic feature of this machine lies in its ability to automatically and completely scutch by buffing or roughing and cleaning and finishing both ends of the rolled and broken flax straw, without the aid of an experienced scutcher.

The complete machine, denominated a *unit*, comprises four complete scutching wheels and a like number of gripping devices for carrying forward and simultaneously holding the strick of flax during the operation of scutching. Each scutch wheel may carry from six to twelve blades.

Fig. 91 diagrammatically illustrates the essential features

of this mechanism and represents the half unit for buffing and cleaning the root ends of the straw. The other half unit, which buffs and cleans the reverse or top end of the straw, is an exact duplicate of the first ; this is chiefly because of the necessity and convenience of making adjustments for the root and top ends of the straw. No. 1 indicates the position of the scutching wheel shaft, situated immediately above the floor line ; its speed varies from 175 to 250 revolutions per minute ; 2 is the boss and arms, and 3 the rim of the wheel, 3 ft. in diameter ; 4 shows six Irish blades of standard dimensions, tapered and bevelled ; the combined action of the blades produces from 1,050 to 1,500 beats per minute, or an approximate surface velocity of 3,300 to 4,710 ft. per minute.

A strong vertical bracket iron casting 5 supports two simple levers 6 and 7, pivoted on studs 8 and 9 respectively. A flange pulley 10 is pivoted on the stud 11, adjusted in the short arm of lever 6 ; a similar pulley 12 is pivoted on the stud 13 adjusted in the short arm of lever 7. Both the pulleys, 10 and 12, are therefore in suspension, but they are balanced as required by the longer arms and adjustable weights W. A pair of pulleys, 14 and 16, are supported and free to rotate on the adjustable but meanwhile fixed studs, 15 and 17 respectively. Duplicates of these pulleys and supports are shown, inversely and respectively, at 18 and 20 and 19 and 21. An endless woven belt 22 passes over the suspended tension pulley 12, then between the pairs of pulleys 14 and 16 and 18 and 20. A second endless belt 23 of like material passes over the upper suspended tension pulley 10. As the belt 23 passes tangentially the pulley 12, it is in close contact with the periphery of the belt 22 at the initial point of contact of the two belts.

This close contact of the two belts is continuously maintained as they simultaneously and uniformly travel along to, and between the fixed pulleys 14 and 16 and 18 and 20 to pulley 12, where they separate. The intensity of the grip is greatest between the points *x* and *y* of the pulleys 14 and 16

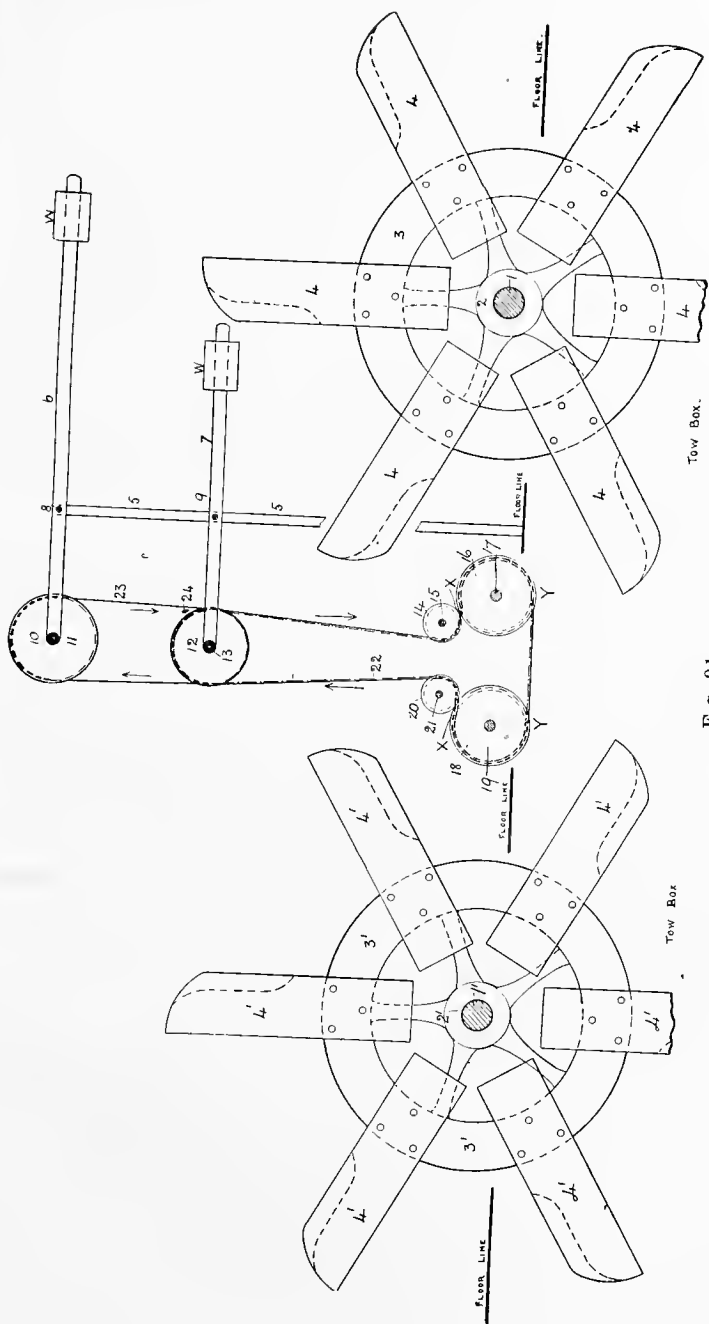


Fig. 91

and 18 and 20. Any increase of tension can be obtained by adjusting or increasing the weights W.

The whole of the parts 5 to 23 are adjustable laterally at right angles to direction of the rotation of the scutching blades.

The space between the buffing blades 4 and the front of the pulleys 14 and 16 is $\frac{5}{8}$ in., and that between the finishing blades, 4', is $1\frac{1}{4}$ in. The respective distances, between the blades and the gripping belts for the second half unit of this machine, which scutches the reverse and top ends of the flax straw, are $\frac{5}{16}$ in. to $\frac{5}{8}$ in. approximately, dependent upon the quality and condition of the retted and rolled straw.

There are other minor, but important, details of adjustment which do not necessarily effect the fundamental principles of this machine.

120. *Principle and Operation of Automatic Scutching.*—The boy, girl, or other unskilled attendant places the stricks of straw in repeated succession between the grips of the belts in their initial contact on the pulley 12, as indicated in the position 24. Fully half of the root end of the straw must project in front of the gripping belt, in which condition it is conveyed forward to and between the pulleys 14 and 16 and 18 and 20. Each strick of straw, as it passes between the gripping points *x* and *y*, receives a series of successive blows from the rapidly rotating blades 4 and 4', by which means the woody part is separated from the fibre.

When the flax, with the root end completely scutched, emerges from the grip of the belts, as indicated at the position 25, it is taken by a second attendant, who then reverses the straw and continuously feeds the stricks into the second and adjacent half unit of the machine; here the operation is simultaneously and correspondingly performed. Frequently two stricks are put together in this machine which scutches the "tops" in the same way as the finisher does in hand scutching.

The production of this machine is equal to about eight stands of the usual type with experienced scutchers, but at a considerable saving in cost.

The Helsing Flax Breaker and Scutching Machine.—This machine is designed to combine the operation of simultaneously breaking and scutching the retted flax straw. The invention is of Swedish origin and the British proprietors are Messrs. James Mackie & Sons, Ltd., Belfast.

The mechanism consists essentially of (1) a pair of plain feed rollers ; (2) of three pairs of fluted steel rollers, the teeth of which intermesh to about half their depth, their speed is relatively high and their function is to thoroughly break the retted dry flax straw ; and (3) a pair of rapidly rotating scroll-shaped, bottomless rollers designed to remove, largely by centrifugal force the woody part of the straw and leave the fibre in the hands of the operator. All the foregoing rollers (except three) can be made to rotate in either direction at the will of the operator. The machine measures 8 ft. \times 6 ft., and requires from $1\frac{1}{2}$ to 3 H.-P. to drive it.

The operation of rolling and scutching is simple and expeditious, no previous experience being necessary. The root ends of each strick of flax straw is fed by hand on to an endless canvas sheet and conducted through the pair of feed rollers into the breaking and scutching rollers. Immediately the flax straw has travelled a distance sufficient to scutch fully one-half its length, the operator by a slight movement of the body adjusts a simple clutch lever which instantly reverses the direction of the rotation of the rollers. The strick of flax is then reversed and the top end is similarly treated. In practice this machine breaks and buffs the flax. A final cleaning on the scutching blades is still necessary. The machine embodies a new principle and is therefore worthy of note.

CHAPTER XIII

MARKETING FLAXES

121.—Buying and Selling of Flaxes. 122.—Irish Flaxes. 123.—Belgian Flaxes. 124.—Flemish Flaxes. 125.—Walloon Flaxes. 126.—French Flaxes. 127.—Conditions of Sale. 128.—Russian Flaxes. 129.—Belgian, Dutch and French Flaxes, Basis of Sale. 130.—Russian Flaxes, Basis of Sale. 131.—Examples on Market Equivalents of Flax Prices. 132.—Summary of Flax Productive Results.

121. Buying and Selling of Flaxes.—The chief flax producing countries are: Russia, Belgium, Holland, Ireland, France, Germany, and prospectively, British East Africa.

The mode of packing and basis of sale vary in each country, hence it is essential to become conversant with each respective system of weights and money values.

122. Irish Flaxes.—Irish flaxes are bought and sold at shillings per stone, except in some few markets, where the rate of exchange is shillings per cwt.

Foreign flaxes are usually converted from their customary rate of exchange into pounds sterling per ton.

123. Belgian Flaxes.—Flax produced in Belgium may be classed under three chief divisions: (a) River retted; (b) Pool retted, denominated “blue flax”; and (c) Dew retted.

The Belgians adopt the same monetary standard as the French, viz.: 1 franc of 100 centimes = 9·513d. or 25·22 francs per pound sterling (normal rate of exchange).

The basis of sale in most markets of Western Europe is in terms of coinage and weights which are now obsolete.

The markets or district varieties and bases of sale are tabulated in the following pages, together with their normal market equivalents and also the method of reducing the same into pounds sterling per ton (see Table I).

124. Flemish Flaxes, which are frequently sold in Bruges

market, are not infrequently offered at pounds sterling per ton.

125. *Walloon Flaxes*, which are dew retted, include Tournai, Namur, Ath, Lieuse, Liege and Gembloux, and are frequently offered in the Ghent market at francs per bale of 100 kilogrammes.

126. *French Flaxes* are frequently offered in the Lille market at pounds sterling per ton or francs per 100 kilogrammes.

127. *Conditions of Sale*. To the initial cost of the flax fibre the dealers charge factorage from 2 to 4 francs per bale for bales and baling, and commission from 1 to 4 per cent. Usually 3 francs is charged per bale of 2 cwts. or its equivalent, which includes 1 franc for the bale and 2 francs for baling and 3 per cent. commission.

All flax, except otherwise arranged, is sold at customer's risk ex store to destination.

128. *Russian Flaxes* are chiefly collected for sale in the markets of Riga, Hoff, Pernau and Fellin. The basis of sale is expressed in pounds sterling per ton, to which initial cost of fibre must be added the amount charged for baling and commission.

The flax from each district is represented by "base marks," and the various qualities of flax in each respective market are indicated by different markings as per Table II.

The state of the market determines the value of the base mark. All other qualities and markings are automatically and relatively increased or decreased, as per Table II.

TABLE I

129. BELGIAN, DUTCH AND FRENCH FLAXES—BASIS OF SALE

Group.	Market.	Basis of Sale.	Markets Equivalents, etc.	Constant Number.
1	*Courtrai . .	Crowns per Sac.	1 Crown = 5·8 francs; 1 Sac = 41 bottles; 72 bottles = 1 bale; 720 bottles = 1 ton.	4·04
	do. . .	Francs per 100 kilogrs.	1 bale contains 101½ to 103 kilogrs. Net.	
2	Ecloo . . .	Francs per bale	1 bale = 72 bottles = 2 cwt.	
	do. . .	Francs per 100 kilogrs.	1 bale contains 101½ to 103 kilogrs. Net.	
3	Ghent . . .	Stuivers per St.	1 stuiver = 9·06 cen- times	
	Thiselt . . .	do.	340 stones = 1 ton .	
	Wella . . .	do.		
4	Bruges . . .	Stuivers per St.	270 stones = 1 ton .	
5	Lokern . . .	Stuivers per St.	360 stones = 1 ton .	
	St. Nicholas . .	do.	360 stones = 1 ton .	
6	Walloon . . .	Sous per botte	1 sou = 5 centimes; 700 bottles = 1 ton	
7	Furness . . .	do.	1 sou = 5 centimes; 710 bottles = 1 ton .	
8	Dutch . . . (Rotterdam)	Stuivers per St.	1 stuiver = $\frac{1}{20}$ guild; 12 guilds = £1; 360 stones = 1 ton .	
9	Groningen . .	do.	do. do.	
10	Friesland . .	do.	320 stones = 1 ton .	
11	Bernay . . .	Francs per 110 livres	2,040 lives = 1 ton .	
12	Bergues . . .	Sous per botte	680 bottles per ton .	
13	Hasnon . . .	do.	720 bottles per ton .	
14	Lille . . .	Francs per 100 kilogrs.	101½ to 103 kilogrs. per bale.	

TABLE II

130. RUSSIAN FLAXES—BASIS OF SALE

Group.	Market.	Base Mark.	Quality, Mark and Relative Value to the Base Mark.					
1	Riga . . . (Crown flaxes)	K	PK	SPK	ZK	R		
		—	+ £3	+ £7	+ £10	+ £13/10		
2	Hoff . . . (Crown flaxes)	HD	PHD	FHD	SFHD	XHDX	XXRX	
		—	+ £3	+ £6	+ £9	+ £12	× £16	
3	Pernau . . . (Crown flaxes)	D	LOD	OD	D	HD	R	G
		—	- £6	- £3	—	+ £4	+ £8	+ £11
4	Fellin . . . (Crown flaxes)	+ £2	- £4	- £1	+ £2	+ £6	+ £10	+ £13

* Courtrai Flax, though originally sold at Crowns per Sac of 41 bottles, is now usually made up into bales of 72 bottles, but the quotation is still in Crown per Sac of 41 bottles, to which, when an artificial value of 10·18 crowns per franc is given, the product of the crowns per "sac" and this artificial value equals francs per bale of 72 bottles = 2 cwt.

131. EXAMPLES ON MARKET EQUIVALENTS OF FLAX PRICES

Example 1.—If Courtrai flax is sold at 46 crowns per sac of 41 bottles, find its equivalent value in francs per bale of 72 bottles net.

	Frcs. per	Bottes per
Crowns.	Crown.	Bale.

Then $\frac{46 \times 5.8 \times 72}{41 \text{ bottles per sac.}} = 468.52 \text{ francs per bale of 72 bottles.}$

Example 2.—Find the constant number, which when multiplied by crowns per sac of 41 bottles will be equivalent to francs per bale of 72 bottles.

Assume 1 sac to cost 1 crown.

Then $\frac{1 \times 5.8 \times 72}{41} = 10.18 \text{ francs per bale of 72 bottles.}$

\therefore The product of crowns per sac of 41 bottles and the constant value of 10.18 francs will always be equal to the francs per bale of 72 bottles.

Example 3.—If Courtrai flax is bought at 48 crowns per sac of 41 bottles, find its equivalent in pounds sterling per ton net.

	Frcs. per	Bottes per
Crowns.	Crown.	ton.

Then $\frac{48 \times 5.80 \times 720}{41 \times 25.22} = \text{£}193 \text{ 16s. 10d.}$

bottes per sac.	frcs. per pound.
-----------------	------------------

Example 4.—Ascertain the constant number which when multiplied by crowns per sac of 41 bottles, will express the equivalent in pounds sterling per ton.

Assume that the cost per sac to be 1 crown.

Then $\frac{1 \times 5.8}{41} \times \frac{720}{25.22} = \text{£}4.04 \text{ per ton.}$

\therefore The product of the Flemish crowns per sac of 41 bottles and the constant number 4.04 will always be equivalent to the pounds sterling per ton.

Example 5.—120 bales of Courtrai flax are offered at 100 francs

per 100 kilogrammes. Find the total cost of the flax in francs and pounds sterling when each bale contains 103 kilogrammes, and 3 francs are charged for factorage, bales and baling in addition to 3 per cent. commission on the initial cost of the flax fibre.

$$\text{Then initial cost of fibre} = \frac{103 \times 120 \times 100}{100} = 12360 \text{ fres.}$$

$$\text{and commission at 3 per cent.} = \frac{12360 \times 3}{100} = 370.80 \text{ fres.}$$

$$\text{also factorage at 3 fres. per bale} = 120 \times 3 = 360 \text{ fres.}$$

$$\text{Total cost ex store in francs} = 13090.80,$$

$$\text{and total cost in money sterling} = \frac{13090.80}{25.22} = \text{£}519 \text{ 1s. 3d.}$$

Example 6.—If flax is offered in Ghent market at 120 stuivers per stone, what is the equivalent price in pound sterling per ton?

	Centimes	Stones	
Stuivers,	per stuiver,	per ton.	

$$\text{Then } \frac{120 \times 9.06 \times 340}{100 \times 25.22} = \text{£}146 \text{ 8s. 0d. per ton.}$$

Centimes per pound stg.

Example 7.—If a quantity of dew retted, Walloon flax is offered at 110 sous per botte, ascertain the equivalent price in pounds sterling per ton.

Then sous per botte \times centimes per sou \times bottles per ton.

$$\frac{110 \times 5 \times 700}{100 \times 25.22} = \text{£}154$$

Centimes per pound stg.

Example 8.—If Bruges flax is offered at 160 stuivers per stone, ascertain its equivalent net cost in pounds sterling per ton.

	Stuivers	\times	Centimes	\times	Stones	
	per stone,		per stuiver,		per ton.	

$$\text{Then } \frac{160 \times 9.06 \times 270}{100 \times 25.22} = \text{£}153 \text{ 12s. 0d.}$$

Centimes in pound stg.

Example 9.—Dutch flax is bought in Rotterdam at 104 stuivers per stone, ascertain the equivalent cost in pounds sterling per ton.

Stuivers per stone \times Stones per ton.

$$\text{Then } \frac{104 \times 360}{1 \times 20 \times 12} = \text{£156 per ton.}$$

No. of stuivers in pound stg.

132. SUMMARY OF FLAX PRODUCTIVE RESULTS

A. Flax Seed for Sowing

1. Weight of 1,000 pickles of air-dried seed = 4.4 to 4.8 grammes.
2. Germination of good flax seed = 90 to 95 per cent.
3. Purity of good flax seed = 92 to 95 "
4. Dimension of seed = $\frac{1}{6}$ in. in length, $\frac{1}{12}$ in. in breadth.
5. Quantity of flax seed per statute acre = 7 pecks.

B. Average yield of Straw, Bolls, and Fibre per statute acre

1. Fresh pulled green straw with bolls = 765 stones
2. Dry straw with bolls = 357 "
3. Descseeded dry straw (rippled) = 225 "
4. " dry retted straw = 180 "
5. Scutched flax = 32 "
6. Rescutched tow = 11 "
7. Total flax fibre = 43 "

C. Average yield of clean Bolls and Seed per statute acre

1. Clean dry bolls = 112 stones
2. Clean dry seed = 57 "
3. Clean chaff, small and broken seeds = 53 "
4. Dust and waste = 2 "

The green flax plant contains 50 to 56 per cent. of water, 42 to 46 per cent. of organic matter, 1.3 to 1.6 per cent. of ash.

The dry flax straw contains 25 to 30 per cent. of bast fibre—the balance is wood and skin. Flax properly handled should yield 18 to 20 per cent. of clean scutched flax and 6 to 7 per cent. of clean re-scutched tow.

Many special examples could be given which appreciably exceed the above average yields; and conversely there have been instances unfortunately much below the results tabulated above, but which are nevertheless well within the reach of flax growers who exercise a reasonable amount of diligence, judgment and care.

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